Weird Chemist

DPP-8 Solutions —

Le Chatelier Principle

Chapter: Chemical Equilibrium

Master Formulae — Le Chatelier Principle

1. Pressure / Volume Effect (Gas reactions):

- Pressure increase ⇒ shift toward **fewer moles of gas** side ($\Delta n_g < 0$ side)
- Pressure decrease (Volume increase) ⇒ shift toward **more moles of gas** side
- $\Delta n_g = 0 \Rightarrow$ **No effect** of pressure/volume
- Only *gaseous* moles count! Solids/liquids ignore karo.

2. Temperature Effect:

- Temperature increase ⇒ shift toward **endothermic** direction
- Temperature decrease ⇒ shift toward **exothermic** direction
- Temperature changes K; pressure changes only equilibrium position (not K)

3. Inert Gas Effect:

- **Constant Volume**: Partial pressures of reactants/products unchanged ⇒ **No shift**
- **Constant Pressure**: Volume increases ⇒ partial pressures decrease ⇒ shift toward **more moles** side

4. Summary Table:

Change	$\Delta n_g > 0$ (more products)	$\Delta n_g < 0$ (fewer products)
P increases	Backward	Forward
P decreases	Forward	Backward
T increases (exo fwd)	Both shift backward	Both shift backward

Quick Answer Key — DPP-8 All 45 Questions

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	(2)	10	(1)	19	(2)*	28	(4)	37	(4)
2	(2)	11	(1)	20	(3)	29	(3)C	38	(1)
3	(2)	12	(4)	21	(3)	30	(3)C	39	(4)
4	(3)	13	(1)	22	(3)	31	(1)A	40	(2)
5	(2)*	14	(1)	23	(3)	32	(4)	41	(2)†
6	(3)	15	(2)	24	(3)	33	(2)	42	(1)
7	(3)	16	(3)	25	(2)	34	(4)	43	(3)
8	(1)	17	(4)	26	(3)	35	(2)	44	(2)
9	(3)	18	(1)	27	(3)	36	(1)	45	(4)

* = Competing effects (explanation mein detail diya hai); †= Possible question typo

GROUP A — Effect of Pressure / Volume

Q1. Not affected by change in volume of flask? [AIEEE-2002]

Explanation (Step-by-Step)

Volume change pressure change karta hai. Pressure change tabhi equilibrium ko affect karta hai jab $\Delta n_g \neq 0$.
$\Delta n_g = 0$ wali reaction volume/pressure se **bilkul affect nahi hoti**.
Saari reactions check karo:

- (1) $PCl_5 \rightleftharpoons PCl_3 + Cl_2$: $\Delta n_g = 2 - 1 = +1 \rightarrow$ Affected
- (2) $N_2 + O_2 \rightleftharpoons {}_2NO$: $\Delta n_g = 2 - 2 = \mathbf{0} \rightarrow$ **NOT Affected!**
- (3) $N_2 + {}_3H_2 \rightleftharpoons {}_2NH_3$: $\Delta n_g = 2 - 4 = -2 \rightarrow$ Affected
- (4) $SO_2Cl_2 \rightleftharpoons SO_2 + Cl_2$: $\Delta n_g = 2 - 1 = +1 \rightarrow$ Affected

Approach

Start karo: Har reaction ka Δn_g calculate karo: (product gas moles) − (reactant gas moles).
End: Jis reaction ka $\Delta n_g = 0 \Rightarrow$ pressure/volume se no effect $\Rightarrow$ Option (2).

Answer

Option (2): $N_2 + O_2 \rightleftharpoons {}_2NO$ ($\Delta n_g = 0$, pressure/volume change ka koi asar nahi)

Q2. Unaffected by change in pressure or volume?

Explanation

Same logic — $\Delta n_g = 0$ dhundho. **Solids aur liquids count nahi karte** only gaseous moles count!

- (1) ${}_2NOCl \rightleftharpoons {}_2NO + Cl_2$: Gas $\Delta n_g = 3 - 2 = +1 \rightarrow$ Affected
- (2) $H_2 + CO_2 \rightleftharpoons H_2O + CO$: Sab gases hain! $\Delta n_g = 2 - 2 = \mathbf{0} \rightarrow$ **Not affected!**
- (3) ${}_3PbS(s) + {}_3O_2(g) \rightleftharpoons {}_2PbO(s) + {}_2SO_2(g)$: Solids ignore karo! Gas: $\Delta n_g = 2 - 3 = -1 \rightarrow$ Affected
- (4) $PCl_5 \rightleftharpoons PCl_3 + Cl_2$: $\Delta n_g = +1 \rightarrow$ Affected

Approach

Key trick: Option (3) mein solid PbS aur PbO hain — inhe gaseous moles mein mat gino. Sirf gas species count karo!

Common Mistake

Option (3) mein students PbS ke 3 aur PbO ke 2 count karte hain aur sochte hain $\Delta n = -1$. Lekin **solids ko hamesha ignore karo** jab Δn_g calculate karo!

Answer

Option (2): $H_2 + CO_2 \rightleftharpoons H_2O + CO$ ($\Delta n_g = 0$)

Q3. Which reaction yield is unaffected by high pressure?

Explanation

Unaffected by pressure $\Rightarrow \Delta n_g = 0$.

- (1) $PCl_3 + Cl_2 \rightleftharpoons PCl_5$: $\Delta n_g = 1 - 2 = -1 \rightarrow$ Affected (pressure favors forward)
- (2) $N_2 + O_2 \rightleftharpoons {}_2NO$: $\Delta n_g = 2 - 2 = \mathbf{0} \rightarrow$ **Unaffected!**
- (3) $N_2 + {}_3H_2 \rightleftharpoons {}_2NH_3$: $\Delta n_g = -2 \rightarrow$ Affected
- (4) ${}_2SO_2 + O_2 \rightleftharpoons {}_2SO_3$: $\Delta n_g = 2 - 3 = -1 \rightarrow$ Affected

Approach

Same rule: $\Delta n_g = 0 \Rightarrow$ Pressure ka koi effect nahi $\Rightarrow$ Option (2).

Answer

Option (2): $N_2 + O_2 \rightleftharpoons {}_2NO$ ($\Delta n_g = 0$)

Q4. Decreasing pressure shifts equilibrium to the RIGHT?

Explanation

Pressure decrease (volume increase) $\Rightarrow$ system shifts toward **more moles of gas** side.
Right shift = forward direction = products banengi = product side pe zyada gas moles.
$\Delta n_g > 0$ (product side pe zyada moles) wali reaction forward shift hogi jab pressure decrease.

- (1) $N_2 + {}_3H_2 \rightleftharpoons {}_2NH_3$: $\Delta n_g = 2 - 4 = -2 \rightarrow$ P decrease $\Rightarrow$ **backward** (LEFT)
- (2) $H_2 + I_2 \rightleftharpoons {}_2HI$: $\Delta n_g = 0 \rightarrow$ No effect
- (3) $N_2O_4 \rightleftharpoons {}_2NO_2$: $\Delta n_g = 2 - 1 = +\mathbf{1} \rightarrow$ P decrease $\Rightarrow$ **forward (RIGHT!)**
- (4) $H_2 + Cl_2 \rightleftharpoons {}_2HCl$: $\Delta n_g = 0 \rightarrow$ No effect

Approach

Start: $\Delta n_g > 0$ wali reaction dhundho (product side zyada moles).
End: $\Delta n_g = +1$ for $N_2O_4 \rightleftharpoons {}_2NO_2$. Pressure decrease $\Rightarrow$ right shift $\Rightarrow$ Option (3).

Answer

Option (3): $N_2O_4 \rightleftharpoons {}_2NO_2$ ($\Delta n_g = +1$; pressure decrease $\Rightarrow$ forward/right shift)

Q5. $SO_2(g) + \frac{1}{2}O_2(g) \rightleftharpoons SO_3(g)$ + heat; both pressure and temperature increased?

Explanation (Competing Effects)

Yahan **dono effects compete karte hain!** Pehle alag alag analyze karo:

Effect of Pressure increase:
$\Delta n_g = 1 - (1 + 0.5) = -0.5$ (product side fewer moles) ⇒ P increase ⇒ **Forward shift**

Effect of Temperature increase:
Forward reaction exothermic hai ("+ heat" on right side).
T increase ⇒ endothermic direction favored ⇒ **Backward shift**

Net result: Dono effects ek doosre ke against hain! Temperature increase ka effect fundamental hai kyunki K ki value hi change ho jaati hai (decrease hoti hai). Pressure sirf equilibrium position shift karta hai, K nahi badlta.
⇒ Temperature effect dominant maana jaata hai ⇒ **Backward increases**

Common Mistake + Important Note

Jab dono (P aur T) increase hon aur effects compete karein, toh exactly kitna shift hoga yeh numerically bina solve kiye determine nahi ho sakta. Lekin exam mein standard answer hai **(2) Backward increases** — temperature ka K pe fundamental effect dominant mana jaata hai.

Approach

Start: Pressure aur temperature ke effects alag-alag dekho.
End: P ↑ → forward; T ↑ → backward (exothermic). Effects compete. Standard answer: backward.

Answer

Option (2): Backward increases (temperature increase exothermic reaction ko backward shift karta hai)

Q6. In which reaction equilibrium moves LEFT when pressure is increased?

Explanation

Pressure increase ⇒ shift toward **fewer** gas moles side.
LEFT shift jab pressure badhao ⇒ Reactant side mein FEWER moles chahiye ⇒ Product side mein MORE moles ⇒ $\Delta n_g > 0$.

- (1) $H_2 + Cl_2 \rightleftharpoons {}_2HCl$: $\Delta n_g = 0 \rightarrow$ No shift
- (2) ${}_2Mg(s) + O_2(g) \rightleftharpoons {}_2MgO(s)$: Gas moles: Reactant = 1 (O_2), Product = 0. $\Delta n_g = -1$ → P increase ⇒ **forward** (not left)
- (3) ${}_2H_2O \rightleftharpoons {}_2H_2 + O_2$: $\Delta n_g = 3 - 2 = +\mathbf{1}$ (products = 3 gas moles > reactants = 2) → P increase ⇒ shift toward fewer moles = **LEFT!**
- (4) $N_2 + {}_3H_2 \rightleftharpoons {}_2NH_3$: $\Delta n_g = -2 \rightarrow$ P increase ⇒ forward (right)

Option (3): Products (${}_2H_2 + O_2$) have MORE gas moles. Pressure increase ⇒ left shift!

Approach

Start: Left shift at high P ⇒ $\Delta n_g > 0$ (products wali side pe zyada moles).
End: Option (3): ${}_2H_2O \rightleftharpoons {}_2H_2 + O_2$, $\Delta n_g = +1$ ⇒ P increase ⇒ left.

Common Mistake

Option (2) mein Mg solid hai — gas nahi! Sirf O_2 count hogi reactant side pe. Product side pe MgO bhi solid! So gas $\Delta n_g = 0 - 1 = -1$, forward shift hoga, not left.

Answer

Option (3): ${}_2\mathbf{H_2O} \rightleftharpoons {}_2\mathbf{H_2} + \mathbf{O_2}$ ($\Delta n_g = +1$; pressure increase ⇒ left shift)

Q7. 2A(g) + 3B(g) ⇌ 3C(g) + D(g). Pressure reduced to half.

Explanation

Step 1: Δn_g calculate karo:

$$\Delta n_g = (3 + 1) - (2 + 3) = 4 - 5 = \mathbf{-1}$$

Product side mein FEWER gas moles ($4 < 5$).
Step 2: Pressure REDUCED to half (volume doubled): Le Chatelier ⇒ shift toward **MORE** gas moles side ⇒ **Reactant side (LEFT/Backward)**
Step 3: So A aur B increase honge, C aur D **decrease** honge.
∴ The amount of D **decreases**.

Approach

Start: $\Delta n_g = -1$ (reactants have more moles).
End: P reduced ⇒ shift toward more moles ⇒ backward shift ⇒ C and D decrease ⇒ Option (3).

Answer

Option (3): The amount of D decreases (backward shift, C aur D dono decrease karte hain)

Q8. Gas mixture compressed: $N_2O_4 \rightleftharpoons 2NO_2$. Le Chatelier prediction?

Explanation

$\Delta n_g = 2 - 1 = +1$ (product side mein MORE moles).
Compression = pressure increase ⇒ shift toward **FEWER** moles side ⇒ toward N_2O_4 (reactant) ⇒ **Backward favoured.**
NO_2 toot ke N_2O_4 banega.

Approach

P increase + $\Delta n_g > 0$ ⇒ Backward shift. Simple!

Answer

Option (1): Backward favoured ($N_2O_4 \rightleftharpoons {}_2NO_2$: compression ⇒ backward toward fewer moles)

GROUP B — Effect of Temperature, Pressure, Volume, Concentration

Q9. **$H_2 \rightleftharpoons$ H + H ($\Delta H = +$ve). Most favorable conditions for forward reaction?**

Explanation

Reaction analyze karo:

- $\Delta H > 0$ (endothermic) $\Rightarrow$ High temperature forward reaction favor karta hai
- $\Delta n_g = 2 - 1 = +1$ (more product moles) $\Rightarrow$ Low pressure (high volume) forward favor karta hai

Toh chahiye: **Highest T + Lowest P**
Options compare karo:

- (1) 2000°C, 760 mm Hg
- (2) 3500°C, 100 cm Hg = 1000 mm Hg (high T but high P too!)
- (3) 3500°C, 1 mm Hg $\Rightarrow$ **Highest T AND Lowest P!**

Option (3) has 3500°C (sabse zyada T) aur 1 mm Hg (sabse kam P) $\Rightarrow$ BEST!

Approach

Start: Endothermic $\Rightarrow$ high T; $\Delta n_g > 0 \Rightarrow$ low P. Dono chahiye.
End: Option (3): 3500°C + 1 mm Hg = highest T + lowest P $\Rightarrow$ Best!

Common Mistake

Option (2) mein T same hai (3500°C) lekin pressure 1000 mm Hg hai jo option (3) ke 1 mm Hg se BAHUT ZYADA hai. Higher pressure = forward reaction ke against. Isliye option (2) nahi, option (3) sahi hai!

Answer

Option (3): 3500°C and 1 mm Hg (highest T + lowest P $\Rightarrow$ maximum forward reaction)

Q10. **$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$; $\Delta H^\circ = -198$ kJ. Favorable condition? [AIEEE-2003]**

Explanation

Temperature analysis:
$\Delta H = -198$ kJ $\Rightarrow$ Exothermic forward reaction.
Low temperature $\Rightarrow$ exothermic direction favored $\Rightarrow$ Forward! (SO_3 zyada banega)
Pressure analysis:
$\Delta n_g = 2 - (2 + 1) = 2 - 3 = -1$ (product side FEWER moles).
High pressure $\Rightarrow$ fewer moles side $\Rightarrow$ Forward! (SO_3 zyada banega)
Dono factors forward ko favor karte hain: Low T + High P

Approach

Start: Exothermic + $\Delta n_g < 0 \Rightarrow$ Low T + High P for forward.
End: Option (1): Lowering temperature and increasing pressure.

Answer

Option (1): Lowering temperature and increasing pressure

Q11. $A_2(g) + B_2(g) \rightleftharpoons X_2(g)$; $\Delta H = -X$ kJ. Maximum product?

Explanation

Temperature: $\Delta H = -X$ kJ (negative) $\Rightarrow$ Exothermic. Low T favors forward.
Pressure: $\Delta n_g = 1 - 2 = -1$ (product fewer moles). High P favors forward.
Maximum product $\Rightarrow$ Low T + High P.

Approach

Exothermic + $\Delta n_g < 0 \Rightarrow$ Low T + High P $\Rightarrow$ Option (1).

Answer

Option (1): Low temperature and high pressure

Q12. $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ + Heat. Forward shift?

Explanation

NH_3 synthesis: Exothermic (+ heat on right), $\Delta n_g = 2 - 4 = -2$.
Check each option:

- (1) **Increasing NH_3 concentration**: Product badhao $\Rightarrow$ Q > K $\Rightarrow$ **Backward!** (Wrong)
- (2) **Decreasing pressure**: $\Delta n_g = -2 \Rightarrow$ P decrease $\Rightarrow$ **Backward!** (Wrong)
- (3) **Decreasing N_2 and H_2**: Reactants decrease $\Rightarrow$ Q > K $\Rightarrow$ **Backward!** (Wrong)
- (4) **Increasing P + Decreasing T**: P increase $\Rightarrow$ fewer moles side (forward!); T decrease $\Rightarrow$ exothermic side (forward!). **Both favor forward!**

Common Mistake

Option (1) is a trap! NH_3 ka concentration badhane se Q > K hota hai $\Rightarrow$ **backward shift**. Students sochte hain "NH3 badhao $\Rightarrow$ NH3 aur banega" — yeh GALAT hai!

Approach

Start: Check each option against Le Chatelier.
End: Only option (4) has BOTH conditions favoring forward $\Rightarrow$ Option (4).

Answer

Option (4): Increasing pressure and decreasing temperature

Q13. $2SO_2 + O_2 \rightleftharpoons 2SO_3$ + heat. Yield of SO_3 MINIMUM if?

Explanation

MINIMUM SO_3 = Backward reaction favored = conditions that disfavor forward.
Forward is: Exothermic ($\Delta H < 0$) + $\Delta n_g < 0$
Disfavor forward (minimum products):

- High T (exothermic forward ko backward dhakelta hai) ⇒ Less SO_3
- Low P ($\Delta n_g < 0$, so low P favors backward) ⇒ Less SO_3

Options:

- (1) T increased + P constant ⇒ T increase ⇒ backward shift ⇒ **Less SO_3**
- (2) T reduced + P increased ⇒ both forward ⇒ More SO_3 (maximum, not minimum)
- (3) Both T and P increased ⇒ T backward, P forward ⇒ Competing effects
- (4) Both T and P decreased ⇒ T forward, P backward ⇒ Competing effects

Option (1) clearly gives backward shift (minimum SO_3) since T increase favors backward unambiguously.

Approach

Start: Minimum SO3 = backward reaction favored.
End: High T (exothermic forward disfavored) + constant P ⇒ definitively backward ⇒ Option (1).

Answer

Option (1): Temperature increased and pressure kept constant

Q14. **aA $\rightleftharpoons$ bB + cC, $\Delta H = -x$ kcal. High P and low T favor products. Then?**

Explanation

Low T favors forward: Forward exothermic hai (consistent with $\Delta H < 0$). Koi restriction on stoichiometry nahi.
High P favors forward: Product side mein FEWER gas moles hone chahiye ⇒ b+c $<$ a ⇒ **a $>$ b+c**

Approach

Start: High P ⇒ fewer product moles ⇒ $b + c < a$.
End: $a > b + c$ ⇒ Option (1).

Answer

Option (1): $a > b + c$

Q15. **N_2 + $3H_2$ $\rightleftharpoons$ $2NH_3$ + 21.9 kcal. Favorable conditions?**

Explanation

Ammonia synthesis (Haber process):

- Exothermic ($+21.9$ kcal on right) $\Rightarrow$ **Low T** favors forward (thermodynamically)
- $\Delta n_g = 2 - 4 = -2 \Rightarrow$ **High P** favors forward
- Catalyst (Fe) $\Rightarrow$ **Required** to speed up reaction (low T pe rate bohot slow hoti hai without catalyst)

$\therefore$ Favorable: Low T + High P + Catalyst

Common Mistake

Industrially, 400-500°C use kiya jaata hai ("low T" not really 0°C) because below this, rate too slow. But in exam, thermodynamic condition = low T. Do NOT confuse industrial compromise with the Le Chatelier-favorable condition!

Approach

Exothermic + $\Delta n_g < 0 \Rightarrow$ Low T + High P + Catalyst $\Rightarrow$ Option (2).

Answer

Option (2): Low temperature, high pressure, catalyst

Q16. Manufacture of NO from N_2 and O_2. Favorable if?

Explanation

Reaction: $N_2 + O_2 \rightleftharpoons {}_2NO$, $\Delta H > 0$ (endothermic — bond breaking energy dominant).

- $\Delta n_g = 2 - 2 = 0 \Rightarrow$ Pressure has **NO effect** (options 1 and 2 wrong!)
- Endothermic $\Rightarrow$ High temperature favors forward (more NO)

Approach

Key trap: $\Delta n_g = 0$, toh pressure ka koi role nahi. Sirf temperature matter karta hai. Endothermic $\Rightarrow$ high T $\Rightarrow$ Option (3).

Answer

Option (3): Temperature is increased

Q17. Same as Q12 — $N_2 + 3H_2 \rightleftharpoons 2NH_3$ + Heat. Forward shift?

Explanation

Yeh Q12 ka exact repeat hai. Same analysis:

- (4) Increasing P + Decreasing T $\Rightarrow$ both favor forward $\Rightarrow$ **Correct!**

Answer

Option (4): Increasing pressure and decreasing temperature (Same as Q12)

Q18. Same as Q11 — $A_2 + B_2 \rightleftharpoons X_2$; $\Delta H = -X$ kJ. Max product?

Explanation

Q11 ka hi repeat hai. Exothermic + $\Delta n_g = -1 \Rightarrow$ Low T + High P.

Answer

Option (1): Low temperature and high pressure (Same as Q11)

Q19. Same as Q5 — $SO_2 + \frac{1}{2}O_2 \rightleftharpoons SO_3$ + heat; P and T both increased?

Explanation

Yeh Q5 ka exact repeat hai. Same analysis: P increase → forward; T increase (exothermic forward) → backward. Effects compete. Standard answer: **Backward increases**.

Answer

Option (2): Backward increases (Same as Q5 — temperature effect on K dominant)

Q20. $NaNO_3$ heated in closed vessel, O_2 liberated. At equilibrium:

Explanation

Reaction: $2NaNO_3(s) \rightleftharpoons 2NaNO_2(s) + O_2(g)$
Option (1): Adding $NaNO_3$: $NaNO_3$ is solid. Solid ka concentration equilibrium mein nahi aata! $\Rightarrow$ No effect. FALSE.
Option (2): Adding $NaNO_2$: $NaNO_2$ is also solid. Same logic $\Rightarrow$ No effect. FALSE.
Option (3): Increasing pressure: $K_p = P(O_2)$ (only gas species).
Pressure badhao $\Rightarrow$ $P(O_2)$ effectively badhta hai $\Rightarrow$ Q > K $\Rightarrow$ **Backward reaction favored**. TRUE!
Option (4): Decreasing temperature: Decomposition of $NaNO_3$ is endothermic (bond breaking).
T decrease $\Rightarrow$ backward (endothermic direction disfavored) $\Rightarrow$ Forward reaction DECREASES, not increases. FALSE.

Common Mistake

Solids add karne se equilibrium kabhi nahi shift hota! Solid activities = 1 hoti hai, change nahi hoti concentration. Students option (1) ya (2) select karte hain galti se.

Approach

Key: Sirf O_2 gas appears in K. Pressure badhao $\Rightarrow$ backward shift.

Answer

Option (3): Increasing pressure favours reverse reaction

Q21. 2A(g) + B(g) $\rightleftharpoons$ C(g) + 362 kcal. Highest yield of C at?

Explanation

Temperature: +362 kcal on right ⇒ Exothermic. **Low T** favors forward (more C).
Pressure: $\Delta n_g = 1 - (2+1) = 1 - 3 = -2$ (fewer product moles). **High P** favors forward.
$\therefore$ Maximum C: Lowest T + Highest P
Options:

- (1) 1000 atm, 500°C
- (2) 500 atm, 500°C
- (3) 1000 atm, 50°C ⇒ **Highest P + Lowest T!**
- (4) 500 atm, 100°C

Option (3): 1000 atm (sabse zyada P) + 50°C (sabse kam T) ⇒ BEST for C formation!

Approach

Exothermic + $\Delta n_g < 0 \Rightarrow$ Low T + High P. Option (3) wins.

Answer

Option (3): 1000 atm and 50°C

Q22. K_p: $10^{-2} \rightarrow 10^{-3}$ as T: 400K → 450K. What can you conclude?

Explanation

Key observation: K_p DECREASE hua ($10^{-2} \rightarrow 10^{-3}$) jab T INCREASE hua (400K → 450K).

Van't Hoff relationship:

- Endothermic reaction: T increase ⇒ K **increases**
- Exothermic reaction: T increase ⇒ K **decreases**

Here: T increased BUT K decreased ⇒ **Reaction is Exothermic** ⇒ **Energy is released!**
Option check:

- (1) K increases with concentration ⇒ FALSE (K only depends on T)
- (2) More molecules on left side ⇒ Partial truth (K<1 means reactants dominate), not the key conclusion
- (3) Energy is released ⇒ **TRUE** (exothermic, K decreases with T)

Approach

Start: K aur T ka relationship dekho.
End: K decreases with T increase ⇒ Exothermic ⇒ Energy released ⇒ Option (3).

Answer

Option (3): Energy is released (K decreases with T increase ⇒ Exothermic reaction)

Q23. Increase in temperature in a reversible equilibrium favours?

Explanation

Temperature increase hamesha **endothermic direction** ko favor karta hai (Le Chatelier).
Agar forward reaction endothermic hai $\Rightarrow$ T increase $\Rightarrow$ forward favored.
Agar forward reaction exothermic hai $\Rightarrow$ T increase $\Rightarrow$ backward (endothermic) favored.
Toh without knowing ΔH of the specific reaction, we cannot say which direction — it depends on the reaction!
$\therefore$ T increase favors "Either forward or backward" depending on the sign of ΔH.

Approach

Rule: T increase $\rightarrow$ endothermic direction. Could be forward OR backward.
$\Rightarrow$ Option (3): Either forward or backward reaction.

Answer

Option (3): Either forward or backward reaction (depends on ΔH of the specific reaction)

GROUP C — Effect of Inert Gas (Constant P / Constant V)

Q24. **$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$. Inert gas at CONSTANT VOLUME. What's true?**

Explanation

Constant volume pe inert gas add karo:
Volume fixed hai. Inert gas add karne se:

- Total pressure badhti hai (inert gas ke moles badhte hain)
- Lekin SO_2, O_2, SO_3 ke moles same hain (inert gas react nahi karta)
- Volume bhi same hai
- $\therefore$ Partial pressure of SO_2, O_2, SO_3 = **UNCHANGED!**

$$P_{\text{partial}} = \frac{n_i RT}{V} \quad \text{— V same, n same} \Rightarrow P_{\text{partial}} \text{ same!}$$

Q nahi badla $\Rightarrow$ **No shift in equilibrium!**

Approach

Start: Constant volume pe inert gas $\Rightarrow$ Partial pressures unchanged.
End: No shift $\Rightarrow$ Option (3).

MOST IMPORTANT CONCEPT in Le Chatelier!

Constant Volume + Inert gas = NO EFFECT (always!)
Ye rule Δn_g ki value pe depend nahi karta. Chahe Δn_g kuch bhi ho, constant volume pe inert gas add karne se KUCH NAHI HOTA. Yeh one of the biggest exam traps hai!

Answer

Option (3): Addition of inert gas does not affect equilibrium

Q25. **$SO_2(g) + \frac{1}{2}O_2(g) \rightleftharpoons SO_3(g)$. Inert gas at CONSTANT PRESSURE (piston moves out). Effect?**

Explanation

Constant pressure pe inert gas add karo:
Piston outward move karta hai ⇒ Volume **increases** to maintain constant total pressure.
Jab volume badhta hai:

- SO_2, O_2, SO_3 ke partial pressures **decrease** (same moles, larger volume)
- Effectively yeh **pressure decrease** jaisa hai inert gas wali reactions ke liye
- Le Chatelier: P decrease ⇒ shift toward MORE moles side
- $\Delta n_g = 1 - (1 + 0.5) = -0.5$ ⇒ Reactant side more moles ⇒ **Backward shift!**

Backward shift ⇒ Less SO_3 produced.

Approach

Start: Constant pressure + inert gas ⇒ volume increases ⇒ partial pressures fall.
End: Effectively P decrease. $\Delta n_g < 0$ ⇒ backward shift ⇒ Less SO_3 ⇒ Option (2).

KEY COMPARISON — Constant V vs Constant P

Condition	Effect on Partial P	Equilibrium?
Inert gas at Constant V	No change	No shift
Inert gas at Constant P	Decrease	Shifts to more moles side

Answer

Option (2): Less SO_3 is produced (backward shift due to volume expansion at constant P)

Q26. **$SO_3 \rightleftharpoons SO_2 + O_2$. Helium introduced: total pressure increases, T and V constant. Dissociation of SO_3?**

Explanation

He is inert gas. Temperature aur Volume **constant** hain.
⇒ Yeh exactly Q24 jaisa hi case hai: **constant volume pe inert gas add kiya!**
Constant volume pe He add karne se:

- SO_3, SO_2, O_2 ke partial pressures **same rehte hain**
- Q nahi badla ⇒ No shift ⇒ Dissociation of SO_3 **unchanged**

Approach

T constant + V constant + inert gas ⇒ Partial pressures unchanged ⇒ No effect.

Answer

Option (3): Remains unaltered (constant volume mein inert gas ka koi effect nahi)

Q27. **$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$. Forward reaction at constant T favored by which conditions?**

Explanation (Step-by-Step)

$\Delta n_g = 2 - 1 = +1$ (product side MORE moles). Forward shift = shift toward more moles side.
Analyze each option:
(a) Inert gas at constant volume: V constant ⇒ Partial pressures unchanged ⇒ **No shift**. Does NOT favor forward.
(b) Introducing Cl_2 at constant volume: Product badhao ⇒ Q $>$ K ⇒ **Backward shift.** Does NOT favor forward.
(c) Inert gas at constant pressure: Volume increases ⇒ Partial pressures decrease ⇒ effectively low P ⇒ shift toward MORE moles (product side, $\Delta n_g = +1$) ⇒ **Forward!**
(d) Increasing volume: Direct volume increase ⇒ P decreases ⇒ shift toward MORE moles = product side ⇒ **Forward!**
(e) Introducing PCl_5 at constant volume: Reactant badhao ⇒ Q $<$ K ⇒ **Forward shift!**

Forward favored by: **(c), (d), (e)** ⇒ Option (3).

Common Mistakes

(a) Trap: Constant volume pe inert gas ⇒ NO effect (not forward!).
(b) Trap: Cl_2 add karna product hai, backward shift hoga!
(e) Correct: Reactant PCl_5 add karna ⇒ Q $<$ K ⇒ forward. Yeh students miss karte hain!

Approach

Start: Har option mein check karo: Q $<$ K hoga ya Q $>$ K, ya partial pressures change honge?
End: (c), (d), (e) forward favor karte hain ⇒ Option (3).

Answer

Option (3): c, d, e

Q28. Effect of adding Krypton (Kr) gas at constant volume on equilibrium?

Explanation

Kr is a noble/inert gas. Constant volume pe add kiya gaya.
Rule: **Constant volume + inert gas = ALWAYS no effect, regardless of Δn_g!**
Kr add karne se:

- Sirf total pressure badhta hai (Kr ke moles badhte hain)
- Reactants/products ke partial pressures, moles, concentrations — **kuch nahi badlta**
- Q = K hi rehta hai ⇒ No shift

Yeh Δn ki value se independent hai!

Approach

Golden Rule: Constant volume + inert gas = NO EFFECT (any Δn).
⇒ Option (4).

Answer

Option (4): No effect whatever be the value of Δn

GROUP D — Assertion–Reason

Q29. **A: Exothermic reaction, extent decreases with T increase. R: T favorable for more products.**

Explanation

Assertion check:
"Reversible exothermic reaction mein T badhane se extent of reaction decreases."
Exothermic forward ⇒ T increase ⇒ backward shift ⇒ Products kam hote hain ⇒ Extent DECREASES. **TRUE!**

Reason check:
"Temperature is favourable for more formation of product."
Yeh GALAT statement hai! Temperature exothermic forward ke liye **UN**favorable hai. T increase se products DECREASE karte hain (exothermic case mein). **FALSE!**

Assertion TRUE, Reason FALSE ⇒ **Option C**

Approach

Start: Assertion aur Reason ko alag-alag true/false judge karo.
A = TRUE; R = FALSE (Reason says T favors products for exothermic, which is wrong!) ⇒ Option (3)C.

Answer

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

Q30. **A: $SO_2 + \frac{1}{2}O_2 \rightleftharpoons SO_3$ forward favored at low T and high P. R: Reaction is endothermic.**

Explanation

Assertion check:
$SO_2 + \frac{1}{2}O_2 \rightleftharpoons SO_3$ + heat. Exothermic reaction hai.
Forward favored: Low T (exothermic) + High P ($\Delta n_g = -0.5$, fewer product moles). **Assertion: TRUE!**

Reason check:
"Reaction is endothermic" ⇒ **FALSE!**
Yeh reaction exothermic hai (+heat on right side), NOT endothermic!

Assertion TRUE, Reason FALSE ⇒ **Option C**

Common Mistake

Students sometimes confuse the SO3 reaction direction. Remember: **$SO_2 \longrightarrow SO_3$ is EXOTHERMIC** (Contact Process, oxidation of SO2). High T is BAD for SO3 yield (used in industry only to speed up reaction with catalyst, not for thermodynamic favor).

Approach

A = TRUE (low T + high P correct for exothermic $\Delta n < 0$); R = FALSE (reaction is exothermic, not endothermic).

Answer

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

Q31. **A: No effect on K when inert gas added. R: K changes only with temperature.**

Explanation

Assertion check:
"K nahi badlta inert gas add karne se." ⇒ **TRUE!**
K sirf temperature pe depend karta hai. Inert gas, concentration, pressure — kuch bhi K nahi badlta.

Reason check:
"K changes only with temperature." ⇒ **TRUE!** Aur yeh Assertion ka CORRECT explanation bhi hai.
Inert gas K nahi badlta kyunki K sirf T pe depend karta hai — yahi toh Reason bol raha hai!

Both TRUE + Reason explains Assertion ⇒ **Option A**

Approach

A = TRUE; R = TRUE; R is the correct explanation of A ⇒ Option (1)A.

Answer

Option (1): A — Both Assertion and Reason TRUE; Reason correctly explains Assertion

GROUP G — Mixed Le Chatelier / Conceptual

Q32. **$CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$ goes to completion in lime kiln because?**

Explanation

Lime kiln mein reaction "complete" kyon ho jaati hai?
Option (4): CO_2 escapes continuously.
Le Chatelier: Agar product (CO_2 gas) continuously remove hota rahe, toh system hamesha $Q <$ K pe rahega (kyunki Q mein CO_2 ki concentration baar baar ghatti rehti hai). System hamesha forward shift karta rahega ⇒ reaction goes to **completion!**

Open kiln hai ⇒ CO_2 gas baahar escape karta rehta hai ⇒ Equilibrium shift hota rehta hai ⇒ **All $CaCO_3$ eventually decomposes.**

Other options wrong kyun?

- (1) High T speeds up but alone doesn't guarantee completion
- (2) Stability is not the reason in this context
- (3) CaO decomposition irrelevant here

Approach

Key concept: Product remove hote rehna ⇒ Q hamesha $<$ K ⇒ Reaction completion tak forward chalti rehti hai.

Answer

Option (4): CO_2 escapes continuously

Q33. **Cis-2-pentene $\rightleftharpoons$ Trans-2-pentene, $\Delta G^\circ = -3.67$ kJ. Excess trans added. What happens?**

Explanation

$\Delta G^\circ = -3.67\,\text{kJ} < 0 \Rightarrow K > 1 \Rightarrow$ Trans form is the more stable/dominant product at equilibrium.
Excess trans form add kiya:
Trans = product. Product badhao ⇒ Q > K ⇒ **Backward reaction!**
Backward reaction mein trans → cis hoga ⇒ **More cis forms!**
System phir se equilibrium pe aayega jab Q = K.

Approach

Start: Trans = product. Excess add karo.
End: Q > K ⇒ backward ⇒ cis increases ⇒ Option (2).

Common Mistake

$\Delta G^\circ < 0$ ka matlab trans stable hai — students sochte hain "zyada trans add karo toh aur trans banega". GALAT! Product add karne se Q > K ⇒ always backward shift!

Answer

Option (2): More cis forms (backward shift, trans → cis)

Q34. **aA $\rightleftharpoons$ ℓL + mM. Volume increase DECREASES degree of dissociation. Then?**

Explanation

Volume increase ⇒ Pressure decrease. Le Chatelier says: shift toward **MORE** moles side.
Normal case: Volume increase ⇒ degree of dissociation INCREASES (agar $\Delta n_g > 0$).
Lekin yahan: volume increase ⇒ degree of dissociation **DECREASES** ⇒ system backward shift kar raha hai!
Backward shift hua jab volume badhaya ⇒ Reactant side mein MORE moles hain ⇒ $a > \ell + m$.

$$\Delta n_g = (\ell + m) - a < 0 \quad \Rightarrow \quad a > \ell + m$$

Approach

Start: Volume up ⇒ normally degree ↑ (if $\Delta n > 0$). But here degree ↓ ⇒ backward shift ⇒ reactant side more moles.
End: $a > \ell + m$ ⇒ Option (4).

Answer

Option (4): $a > \ell + m$

Q35. **$CaCO_3$(s) $\rightleftharpoons$ CaO(s) + CO_2(g) at constant T in closed container. Which changes pressure?**

Explanation

$K_p = P(\text{CO}_2)$ (sirf gas species, solids ignore karo).
At constant T: K_p = constant $\Rightarrow P(\text{CO}_2)$ = constant!
What changes pressure?

- (1) Size of container change: As long as excess CaCO_3 present, $P(\text{CO}_2) = K_p$ stays same. NO change.
- (2) **Temperature change:** K_p depends only on T! T badlao $\Rightarrow K_p$ badle $\Rightarrow P(\text{CO}_2)$ badle $\Rightarrow$ **Pressure changes!**
- (3) Addition of CaO: Solid, no effect on K_p or $P(\text{CO}_2)$.
- (4) Amount of CaCO3: Solid, no effect (as long as excess is present).

Approach

$K_p = P(\text{CO}_2)$. Only temperature changes K_p, which changes $P(\text{CO}_2) \Rightarrow$ Option (2).

Answer

Option (2): Temperature

Q36. At equilibrium in 500 mL: [A]=[B]=[C]=[D] = 1.5 M. 0.5 M of C and D removed. New K_c?

Explanation

Reaction: $\text{A} + \text{B} \rightleftharpoons \text{C} + \text{D}$
Original equilibrium:

$$K_c = \frac{[C][D]}{[A][B]} = \frac{(1.5)(1.5)}{(1.5)(1.5)} = 1$$

After removing 0.5 M of C and D:
Now [A] = [B] = 1.5 M, [C] = [D] = 1.0 M. System shifts forward. Lekin question K_c pooch raha hai, not Q!
KEY CONCEPT: K_c sirf **temperature** pe depend karta hai. Temperature change nahi huyA! So K_c **= SAME = 1.**
C aur D remove karne se sirf Q change hoga, K nahi. System Q $<$ K pe forward shift karega until Q = K = 1 again.

Most Common Mistake in Exams!

Students Q nikalte hain aur wahi answer sochte hain. Q $= (1.0)(1.0)/(1.5)(1.5) = 4/9$ — lekin yeh Q hai, K nahi! **K concentration change se kabhi nahi badlta!** Answer: K = 1 (unchanged).

Approach

Key question: Temperature change hua? NO. $\Rightarrow K_c$ same rahega = 1 $\Rightarrow$ Option (1).

Answer

Option (1): $K_c = 1$ (K sirf T se change hota hai, concentration change se nahi!)

Q37. 20 L container, 400 K, CO_2 at 0.4 atm, excess SrO. $K_p = 1.6$ atm. Container reduced — max volume when CO_2 pressure is maximum?

Explanation (Step-by-Step)

Relevant equilibrium: $SrCO_3(s) \rightleftharpoons SrO(s) + CO_2(g)$
$K_p = P(CO_2) = 1.6$ atm (at 400K). Yeh equilibrium pressure of CO_2 hai.
Initial state:

- $P(CO_2) = 0.4$ atm $< K_p = 1.6$ atm
- Volume = 20 L
- Excess SrO hai (no SrCO3 remaining — all decomposed, so only SrO + CO2 gas)

Volume compress karte hain:
Jab tak $P(CO_2) < K_p$: No SrCO3 can form (no reaction, pure Boyle's law applies).
Compression se $P(CO_2)$ badhega. Jab $P(CO_2)$ exactly $K_p = 1.6$ atm tak pahunche, tab SrO CO2 absorb karna shuru karega:

$$\text{SrO}(s) + \text{CO}_2(g) \rightarrow \text{SrCO}_3(s)$$

Is point ke baad further compression se CO2 absorb hoti rehegi, $P(CO_2)$ = 1.6 atm fixed rehega.
∴ Maximum $P(CO_2)$ = K_p = 1.6 atm (exceeded nahi ho sakta as long as SrO present).
Volume at which $P(CO_2) = 1.6$ atm (Boyle's law, before any reaction):

$$P_1V_1 = P_2V_2 \implies 0.4 \times 20 = 1.6 \times V_2$$

$$V_2 = \frac{0.4 \times 20}{1.6} = \frac{8}{1.6} = \mathbf{5}\text{ L}$$

Approach

Start: $K_p = P(CO_2)$ at equilibrium = 1.6 atm.
Middle: Initially CO2 is below equilibrium pressure. Compress karo until P reaches 1.6 atm using Boyle's law.
End: $V = P_1V_1/P_2 = 0.4 \times 20/1.6 = 5$ L ⇒ Option (4).

Answer

Option (4): 5 L

Q38. **$PCl_5 \rightleftharpoons PCl_3 + Cl_2$. $\alpha \propto 1/\sqrt{p}$. Volume increased 16 times. New α?**

Explanation (Step-by-Step)

Given: $\alpha \propto \frac{1}{\sqrt{p}}$
Step 1: Volume 16 guna badha ⇒ Pressure 16 guna ghata (constant T pe, ideal gas):

$$P_{\text{new}} = \frac{P_{\text{old}}}{16}$$

Step 2: New α calculate karo:

$$\alpha_{\text{new}} \propto \frac{1}{\sqrt{P_{\text{new}}}} = \frac{1}{\sqrt{P/16}} = \frac{1}{\sqrt{P}} \times \sqrt{16} = 4 \times \alpha_{\text{old}}$$

∴ New degree of dissociation = **4 times** the original.

Approach

Start: Volume $\times 16 \Rightarrow$ Pressure $\div 16$.
End: $\alpha \propto 1/\sqrt{P}$; P becomes $P/16 \Rightarrow \alpha$ becomes $4\alpha \Rightarrow$ Option (1).

Answer

Option (1): 4 times $(V \times 16 \Rightarrow P \div 16 \Rightarrow \alpha \times \sqrt{16} = 4\alpha)$

Q39. A(s) $\rightleftharpoons$ 2B(g) + 3C(g). If [C] is doubled, [B] becomes?

Explanation (Step-by-Step)

A is solid $\Rightarrow$ Activity = 1. So:

$$K = [B]^2[C]^3$$

Original equilibrium: $K = [B_0]^2[C_0]^3$
Assumption: At new equilibrium, $[C] = 2[C_0]$ (if we maintain C at double its value OR approximate that C doesn't change much by the small shift).
Step 1: At new equilibrium, K must still hold:

$$K = [B]^2 \cdot (2[C_0])^3 = [B]^2 \cdot 8[C_0]^3$$

Step 2: Equate with original K:

$$[B_0]^2[C_0]^3 = [B]^2 \cdot 8[C_0]^3$$

$$[B]^2 = \frac{[B_0]^2}{8} \implies [B] = \frac{[B_0]}{2\sqrt{2}} = \frac{1}{2\sqrt{2}}[B_0]$$

$\therefore$ [B] becomes $\frac{1}{2\sqrt{2}}$ times original.

Approach

Start: K = $[B]^2[C]^3$ (A is solid, not in K).
Middle: New [C] = $2[C_0]$. K same rahega. Naya [B] nikalo.
End: $[B]_{\text{new}} = [B_0]/2\sqrt{2} \Rightarrow$ Option (4).

Answer

Option (4): $\frac{1}{2\sqrt{2}}$ **times original**

Q40. $Fe(OH)_3$(s) $\rightleftharpoons$ Fe^{3+} + 3OH^-. If [OH^-] decreases to 1/4, [Fe^{3+}] becomes?

Explanation (Step-by-Step)

$Fe(OH)_3$ is solid:

$$K_{sp} = [Fe^{3+}][OH^-]^3$$

Step 1: Original: $K_{sp} = [Fe^{3+}]_0 \cdot [OH^-]_0^3$

Step 2: New $[OH^-] = \frac{1}{4}[OH^-]_0$. At new equilibrium:

$$K_{sp} = [Fe^{3+}]_{\text{new}} \cdot \left(\frac{1}{4}[OH^-]_0\right)^3$$

$$K_{sp} = [Fe^{3+}]_{\text{new}} \cdot \frac{[OH^-]_0^3}{64}$$

Step 3: Equate:

$$[Fe^{3+}]_0 \cdot [OH^-]_0^3 = [Fe^{3+}]_{\text{new}} \cdot \frac{[OH^-]_0^3}{64}$$

$$[Fe^{3+}]_{\text{new}} = 64 \times [Fe^{3+}]_0$$

$\therefore$ $[Fe^{3+}]$ increases to **64 times** original!

Approach

Start: $K_{sp} = [Fe^{3+}][OH^-]^3 = \text{constant}$.
Middle: $[OH^-]$ becomes 1/4 $\Rightarrow$ $[OH^-]^3$ becomes $(1/4)^3 = 1/64$.
End: $[Fe^{3+}]$ must increase by 64 times to keep K_{sp} constant $\Rightarrow$ Option (2).

Common Mistake

Students $[OH^-]$ 1/4 hoti hai toh $[Fe^{3+}]$ 4 times sochte hain (option 3). **GALAT!** $[OH^-]$ cube power mein hai! $(1/4)^3 = 1/64$. Toh $[Fe^{3+}]$ 64 times badhega, not 4 times!

Answer

Option (2): 64 times ($[OH^-]$ decreases to 1/4 $\Rightarrow$ $(1/4)^3 = 1/64$ $\Rightarrow$ $[Fe^{3+}]$ $\times 64$)

Q41. **$PCl_5 \rightleftharpoons PCl_3 + Cl_2$: $P(PCl_3) = 0.3$, $P(Cl_2) = 0.2$, $P(PCl_5) = 0.6$ atm. PCl_3 and Cl_2 pressures doubled. New $P(PCl_5)$?**

Explanation (Step-by-Step)

Step 1: Original K_p:

$$K_p = \frac{P(\mathrm{PCl_3}) \cdot P(\mathrm{Cl_2})}{P(\mathrm{PCl_5})} = \frac{0.3 \times 0.2}{0.6} = \frac{0.06}{0.6} = 0.1 \text{ atm}$$

Step 2: After doubling: $P(\mathrm{PCl_3}) = 0.6$, $P(\mathrm{Cl_2}) = 0.4$, $P(\mathrm{PCl_5}) = 0.6$
$Q = \dfrac{0.6 \times 0.4}{0.6} = 0.4 > K_p = 0.1 \Rightarrow$ Backward shift
Step 3: At new equilibrium, let backward shift by z:

$$\frac{(0.6 - z)(0.4 - z)}{0.6 + z} = 0.1$$

$$(0.6 - z)(0.4 - z) = 0.1(0.6 + z)$$

$$0.24 - z + z^2 = 0.06 + 0.1z$$

$$z^2 - 1.1z + 0.18 = 0$$

$$z = \frac{1.1 \pm \sqrt{1.21 - 0.72}}{2} = \frac{1.1 \pm 0.7}{2}$$

$z = 0.9$ (invalid, gives negative pressures) or $z = 0.2$
Step 4: $P(\mathrm{PCl_5}) = 0.6 + 0.2 = \mathbf{0.8}$ atm
[FLAG: Answer key ke hisaab se (2) 1.2 hai, lekin calculation 0.8 atm deta hai. Q mein P(PCl$_5$) = 0.6 atm ka possible typo, ya answer mein discrepancy hai. Calculation correctly 0.8 deta hai. Students apne teacher se verify karein.]

Approach

Start: K_p original calculate karo.
Middle: New Q vs K compare karo; ICE table banao; solve quadratic.
End: $z = 0.2$, $P(\mathrm{PCl_5}) = 0.8$ atm (calculation ke anusar). Textbook answer (2) 1.2 se discrepancy — flagged.

FLAG: Possible Question Typo

Given data se calculation 0.8 atm deta hai jo options mein nahi hai. Agar $P(\mathrm{PCl_5})$ initial = 0.06 atm hota (likely typo: 0.6 ki jagah 0.06), toh Kp = 1 aur answer ≈ 0.15 atm (option 4) milta. Teacher se original source verify karein!

Answer

Option (2): 1.2 atm (textbook answer; calculation gives 0.8 atm — see flag above)

GROUP D (Extension) — Solubility / Phase Equilibrium

Q42. **Gas–solution equilibrium: effect of pressure and temperature on gas solubility?**

Explanation

Henry's Law: Gas ki solubility pressure ke saath **directly proportional** hoti hai.

$$\text{Equilibrium: Gas} \rightleftharpoons \text{Gas(dissolved)}$$

- **Pressure increase:** $Q < K$ hota hai $\Rightarrow$ More gas dissolves $\Rightarrow$ Solubility **increases**
- **Temperature increase:** Dissolving gas is exothermic process (gas ki KE khatam hoti hai jab dissolve ho). T increase $\Rightarrow$ endothermic direction $\Rightarrow$ Gas solution se baahar aata hai $\Rightarrow$ Solubility **decreases**

Approach

Rule: P up $\Rightarrow$ solubility up. T up $\Rightarrow$ solubility down. $\Rightarrow$ Option (1).

Answer

Option (1): Increases with pressure and decreases with temperature

Q43. $CO_2(s) \rightleftharpoons CO_2(g)$. On cooling?

Explanation

Sublimation equilibrium: Solid CO_2 (dry ice) $\rightleftharpoons$ CO_2 gas.
Cooling = temperature decrease.
Sublimation (solid $\rightarrow$ gas) is **endothermic** (heat absorbed).
T decrease $\Rightarrow$ exothermic direction favored $\Rightarrow$ Gas $\rightarrow$ Solid (condensation/solidification).
$\therefore$ **More gas solidifies** (gas ki quantity decreases, solid ki quantity increases).

Approach

Cooling $\Rightarrow$ T decrease $\Rightarrow$ exothermic direction (solidification) $\Rightarrow$ More gas solidifies $\Rightarrow$ Option (3).

Answer

Option (3): More gas solidifies

Q44. Ice $\rightleftharpoons$ Water. Pressure applied. What happens?

Explanation

Ice $\rightleftharpoons$ Water — yeh water ki anomalous property hai!
Key fact: Water ice se **denser** hoti hai (liquid volume $<$ solid volume).
Pressure increase $\Rightarrow$ Le Chatelier: shift toward **smaller volume** side $\Rightarrow$ Toward **liquid water** (denser = smaller volume).
$\therefore$ **More water will be formed.**
(Yahi wajah hai ki ice skating mein skate blade ke neeche ice ka thoda melt ho jaata hai!)

Approach

Key: Ice $<$ Water in density $\Rightarrow$ Water ka volume chota $\Rightarrow$ High P $\Rightarrow$ water side $\Rightarrow$ Option (2).

Answer

Option (2): More water will be formed

Q45. At constant temperature, on increasing pressure which is correct?

Explanation

Check each option:
(1) Solid $\rightleftharpoons$ Liquid: more liquid formed.
Ice $\rightarrow$ water ke liye TRUE (anomalous). Lekin for MOST substances: solid is denser (smaller V) $\Rightarrow$ P increase $\Rightarrow$ solid favored, not liquid. Option not universally correct.
(2) NH_3 formation decreases.
N_2 + $_3H_2 \rightleftharpoons {}_2NH_3$; $\Delta n_g = -2$. P increase $\Rightarrow$ fewer moles side (forward) $\Rightarrow$ More NH_3. Statement FALSE!
(3) CO_2 + C $\rightleftharpoons$ $_2CO$ shifts forward.
Gas moles: Reactant CO_2 = 1 gas; Product CO = 2 gas. $\Delta n_g = +1$. P increase $\Rightarrow$ fewer moles (backward). Statement FALSE!
(4) Solubility of gas in liquid increases.
Henry's Law: P up $\Rightarrow$ Gas solubility **increases**. **DEFINITIVELY TRUE!**

Approach

Start: Eliminate wrong options:
(2) Wrong — NH3 increases with P.
(3) Wrong — CO2+C: P increase $\Rightarrow$ backward.
(1) Partially true (only for water), not universally.
End: (4) is definitively correct by Henry's Law $\Rightarrow$ Option (4).

Answer

Option (4): Solubility of gas in liquid increases (Henry's Law — P increase $\Rightarrow$ more gas dissolves)

— End of DPP-8 Solutions —

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