

Weird Chemist

DPP-5 Solutions —

Balancing of Redox Reactions

Chapter: Redox Reactions

Master Formulae — Balancing Redox Reactions

1. Half-Reaction Method (Ion-Electron Method) — Steps:

1. Oxidation half-reaction aur reduction half-reaction alag likho
2. Atoms balance karo: pehle element, phir O (add H₂O), phir H (add H⁺ acidic / OH⁻ basic)
3. Charge balance karo: electrons add karo (oxidation side pe right, reduction side pe left)
4. Electrons equal karne ke liye multiply karo, phir add karo

2. Electron Count Formula (Short Method):

$$n_{\text{electrons}} = |\Delta\text{ON}| \times \text{number of atoms changing}$$

3. n-Factor Rules:

- n -factor = electrons transferred per formula unit
- Eq. weight = $\frac{\text{Molar mass}}{n\text{-factor}}$
- KMnO₄ acidic: $n = 5$ (Mn: +7 → +2); KMnO₄ neutral: $n = 3$ (Mn: +7 → +4); KMnO₄ alkaline: $n = 1$ (Mn: +7 → +6)
- K₂Cr₂O₇ acidic: $n = 6$ (2 Cr: +6 → +3, 3 per Cr)

4. Equivalence Principle:

$$\text{meq of oxidising agent} = \text{meq of reducing agent}$$

$$n_1 M_1 V_1 = n_2 M_2 V_2 \quad (\text{jahan } n = n\text{-factor})$$

5. Acidic vs Basic Medium:

- Acidic medium: O balance ke liye H₂O add karo, H balance ke liye H⁺ add karo
- Basic medium: pehle acidic mein balance karo, phir dono sides mein OH⁻ add karo H⁺ neutralize karne ke liye

Quick Answer Key — DPP-5 All 27 Questions

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	(1)5	7	(1)4	13	(1)	19	(4)158	25	(2)5
2	(1)5	8	(4)8	14	(2)	20	(3)	26	(2)
3	(2)3L	9	(1)	15	(3)	21	(1)Two	27	(2)0.05L
4	(2)3	10	(2)	16	(3)	22	(4)2/5		
5	(2)2e ⁻	11	(4)1	17	(2)1:2	23	(3)3/5		
6	(1)3	12	(3)10	18	(2)3/7	24	(3)0.6		

L = Left side

TYPE-1 — Balancing Half-Reactions & Finding Electrons

Q1. Value of n in: $\text{MnO}_4^- + 8\text{H}^+ + ne^- \longrightarrow \text{Mn}^{2+} + 4\text{H}_2\text{O}$

Explanation (Step-by-Step)

Method 1 (ON change):

- Mn in MnO_4^- : +7
- Mn in Mn^{2+} : +2
- Change: +7 \rightarrow +2 = 5 units (reduction = gain of e^-)
- $\therefore n = 5$

Method 2 (Charge balance — verify karo):

$$\text{Left charge: } (-1) + 8(+1) + 5(-1) = -1 + 8 - 5 = +2$$

$$\text{Right charge: } (+2) + 0 = +2 \quad \checkmark$$

Dono sides charge equal $\Rightarrow n = 5$ confirmed!

Approach

Start: Mn ka ON reactant aur product mein nikalo.

End: ON change = electrons needed. Mn: +7 \rightarrow +2, change = 5. $n = 5$.

Answer

Option (1): $n = 5$

Q2. In $\text{MnO}_4^- + x\text{H}^+ + ne^- \longrightarrow \text{Mn}^{2+} + y\text{H}_2\text{O}$, value of n?

Explanation

Same as Q1: Mn: +7 \rightarrow +2, $\Delta\text{ON} = 5$. So $n = 5$.

(For completeness: O balance gives $y = 4$; H balance gives $x = 8$.)

Answer

Option (1): $n = 5$

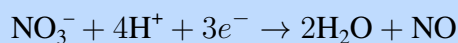
Q3. Electrons needed to balance: $\text{NO}_3^- + 4\text{H}^+ \longrightarrow 2\text{H}_2\text{O} + \text{NO}$

Explanation

Step 1: N ka ON:

- N in NO_3^- : +5; N in NO: +2
- Change: +5 \rightarrow +2 = 3 units (reduction, 3 electrons gained)

Step 2: Electrons **LEFT** side pe aayenge (reduction reaction mein e^- reactant side pe hote hain):



Charge verify: Left: $-1 + 4 + 3(-1) = 0$. Right: 0.

Approach

N: +5 \rightarrow +2 = 3 electrons gained (reduction). Reduction mein e^- LEFT side pe add hote hain.
 \Rightarrow 3 on left side.

Common Mistake

Students sochte hain oxidation mein electrons left side pe hote hain. **RULE:**

Oxidation (losing e^-): e^- appear on **RIGHT** side (product).

Reduction (gaining e^-): e^- appear on **LEFT** side (reactant).

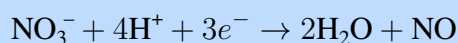
Answer

Option (2): 3 on left side

Q4. Electrons needed: $\text{NO}_3^- + 4\text{H}^+ + e^- \rightarrow 2\text{H}_2\text{O} + \text{NO}$. Number of e^- ?

Explanation

Same as Q3: N: +5 \rightarrow +2 = 3 electrons.



Charge balance: $(-1) + 4 + 3(-1) = 0 = 0$

Answer

Option (2): 3

Q5. $\text{H}_2\text{O} + \text{SO}_3^{2-} \rightarrow \text{SO}_4^{2-} + 2\text{H}^+ + \text{X}$. Value of X?

Explanation

Step 1: S ka ON:

- S in SO_3^{2-} : $x + 3(-2) = -2 \Rightarrow x = +4$
- S in SO_4^{2-} : $x + 4(-2) = -2 \Rightarrow x = +6$
- Change: $+4 \rightarrow +6 = 2$ units (**Oxidation**, 2 electrons lost)

Step 2: Oxidation mein e^- RIGHT side pe aate hain (product side):

$$X = 2e^-$$

Charge verify: Left: $0 + (-2) = -2$. Right: $(-2) + 2(+1) + 2(-1) = -2 + 2 - 2 = -2$

Approach

S: $+4 \rightarrow +6 = \text{oxidation} = 2$ electrons lost. Oxidation mein e^- product (right) side pe $\Rightarrow X = 2e^-$.

Answer

Option (2): $2e^-$

Q6. Value of n: $\text{Cr}(\text{OH})_4^- + \text{OH}^- \rightarrow \text{CrO}_4^{2-} + \text{H}_2\text{O} + ne^-$

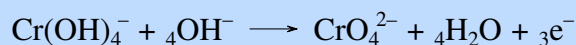
Explanation

Step 1: Cr ka ON:

- $\text{Cr}(\text{OH})_4^-$: $\text{Cr} + 4(-1) = -1 \Rightarrow \text{Cr} = +3$
- CrO_4^{2-} : $\text{Cr} + 4(-2) = -2 \Rightarrow \text{Cr} = +6$
- Change: $+3 \rightarrow +6 = 3$ units (**Oxidation**, 3 electrons lost)

Step 2: Oxidation = e^- RIGHT side pe (product side). $n = 3$.

Balanced half-reaction (full):



Charge: Left: $-1 + 4(-1) = -5$. Right: $-2 + 0 + 3(-1) = -5$

Approach

Cr: $+3 \rightarrow +6 = \text{oxidation} = 3$ electrons lost. $n = 3$.

Answer

Option (1): $n = 3$

Q7. $\text{CH}_3\text{OH} \rightarrow \text{HCOOH}$. Electrons added to RIGHT side?

Explanation

C ka ON nikalo:

- CH_3OH (methanol, CH_4O): $x + 4(+1) + (-2) = 0 \Rightarrow x = -2$. $\text{C} = -2$.
- HCOOH (formic acid, CH_2O_2): $x + 2(+1) + 2(-2) = 0 \Rightarrow x = +2$. $\text{C} = +2$.

Change: $-2 \rightarrow +2 = 4$ units (**Oxidation**, 4 electrons lost).

Oxidation mein e^- RIGHT side pe add karte hain:



\therefore 4 electrons on right side.

Approach

Start: C in $\text{CH}_3\text{OH} = -2$; C in $\text{HCOOH} = +2$.

End: Change = 4 units = oxidation = $4e^-$ on RIGHT.

Common Mistake — ON Calculation!

Students CH_3OH mein $\text{C} = -1$ assume karte hain (sirf C-H bonds count karke). **Correct method:** $\text{H} = +1$, $\text{O} = -2$ use karo. CH_3OH : $\text{C} + 4(+1) + (-2) = 0 \Rightarrow \text{C} = -2$, not -1 .
 HCOOH : $\text{C} + 2(+1) + 2(-2) = 0 \Rightarrow \text{C} = +2$.

Answer

Option (1): 4 (C: $-2 \rightarrow +2$, 4 electrons on right side)

Q8. $3\text{Fe} + 4\text{H}_2\text{O} \rightarrow \text{Fe}_3\text{O}_4 + 4\text{H}_2$. Electrons lost or gained? [NCERT]

Explanation

Fe ka ON:

- Fe (free): 0
- Fe_3O_4 : $3x + 4(-2) = 0 \Rightarrow 3x = +8 \Rightarrow x = +\frac{8}{3}$ (average)

Total ON change for 3 Fe atoms:

$$3 \times \left(\frac{8}{3} - 0 \right) = 3 \times \frac{8}{3} = 8 \text{ electrons lost (oxidized)}$$

H ka ON (verify): H in H_2O : $+1$. H in H_2 : 0. Change: $+1 \rightarrow 0 = 8$ H atoms reduced (4 H_2O has 8 H) = 8 electrons gained.

Both give 8 electrons.

Approach

Key trick: Fe_3O_4 mein Fe ka average ON = $+8/3$. For 3 Fe: total change = 8 electrons.

Common Mistake

Students Fe_3O_4 mein Fe = $+2$ ya $+3$ lete hain (yeh mixed oxide hai: $\text{FeO} + \text{Fe}_2\text{O}_3$). Average ON = $+8/3$. **Total electrons for 3 Fe atoms:** $3 \times 8/3 = 8$, not 6!

Answer

Option (4): 8 (Fe: $0 \rightarrow +8/3$ average, 3 Fe atoms $\times 8/3 = 8$ electrons)

Q9. Balance half-reaction: $\text{CrO}_4^{2-} \rightarrow \text{CrO}_2^- + \text{OH}^-$

Explanation (Step-by-Step, Basic Medium)

Step 1: Cr ka ON:

- CrO_4^{2-} : Cr = +6; CrO_2^- : Cr + 2(-2) = -1 \Rightarrow Cr = +3
- +6 \rightarrow +3 = 3 electrons gained (reduction). $3e^-$ LEFT side pe.

Step 2: Atom balance (O aur H):

- Left: 4 O. Right: 2 O + OH^- ka O. Need to balance with H_2O .
- Try: $\text{CrO}_4^{2-} + 2\text{H}_2\text{O} + 3e^- \rightarrow \text{CrO}_2^- + 4\text{OH}^-$

Verify:

- Cr: 1 = 1
- O: 4 + 2 = 6 left; 2 + 4 = 6 right
- H: 4 left; 4 right
- Charge: $-2 + 0 + 3(-1) = -5$ left; $-1 + 4(-1) = -5$ right

Approach

Start: Cr: +6 \rightarrow +3, $3e^-$ left side. Balance O aur H using H_2O aur OH^- (basic medium).

End: $\text{CrO}_4^{2-} + 2\text{H}_2\text{O} + 3e^- \rightarrow \text{CrO}_2^- + 4\text{OH}^-$ = Option (1).

Answer

Option (1): $\text{CrO}_4^{2-} + 2\text{H}_2\text{O} + 3e^- \rightarrow \text{CrO}_2^- + 4\text{OH}^-$

Q10. Balance: $x \text{Cr}_2\text{O}_7^{2-} + y\text{H}^+ + z e^- \rightarrow a\text{Cr}^{3+} + b\text{H}_2\text{O}$. Find coefficients.

Explanation (Step-by-Step)

Step 1: Cr ka ON:

- $\text{Cr}_2\text{O}_7^{2-}$: $2x + 7(-2) = -2 \Rightarrow x = +6$
- Cr^{3+} : +3. Change: +6 \rightarrow +3 = 3 per Cr.
- Per $\text{Cr}_2\text{O}_7^{2-}$: 2 Cr atoms $\Rightarrow 2 \times 3 = 6$ electrons.

Step 2: Let $x = 1$:

- $a = 2$ (2 Cr per $\text{Cr}_2\text{O}_7^{2-}$)
- $z = 6$
- O balance: 7 O on left $\Rightarrow b = 7$ (H_2O)
- H balance: $b \times 2 = 14 \Rightarrow y = 14$

Balanced: $\text{Cr}_2\text{O}_7^{2-} + 14\text{H}^+ + 6e^- \rightarrow 2\text{Cr}^{3+} + 7\text{H}_2\text{O}$

Charge check: Left: $-2 + 14 - 6 = +6$. Right: $2(+3) = +6$

$x = 1, y = 14, z = 6, a = 2, b = 7$

Approach

Start: Cr: $+6 \rightarrow +3$, $z = 6$ (per $\text{Cr}_2\text{O}_7^{2-}$). O balance: $b = 7$. H balance: $y = 14$.

End: $x=1, y=14, z=6, a=2, b=7 \Rightarrow$ Option (2).

Answer

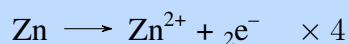
Option (2): $x=1, y=14, z=6, a=2, b=7$

TYPE-2 — Balancing Complete Redox Equations

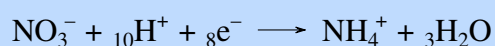
Q11. Balanced: $\text{Zn} + \text{H}^+ + \text{NO}_3^- \rightarrow \text{NH}_4^+ + \text{Zn}^{2+} + \text{H}_2\text{O}$. Coefficient of NH_4^+ ?

Explanation (Half-Reaction Method)

Oxidation half-reaction:

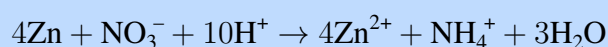


Reduction half-reaction: N: $+5 \rightarrow -3$ in NH_4^+ , change = 8 electrons.



Charge check: Left: $-1 + 10 - 8 = +1$. Right: $+1 + 0 = +1$

Combine: LCM of 2 and 8 = 8. Multiply oxidation $\times 4$:



Coefficient of $\text{NH}_4^+ = 1$

Approach

Start: N: $+5 \rightarrow -3, 8\text{e}^-$. Zn: $0 \rightarrow +2, 2\text{e}^-$.

Middle: 4 Zn provide 8e^- for 1 NO_3^- .

End: 1 $\text{NO}_3^- \rightarrow 1 \text{NH}_4^+$. Coefficient = 1.

Common Mistake

Students N ka ON change $+5 \rightarrow -3 = 8$ electrons galat nikalte hain (sochte hain 3 ya 5). $|+5 - (-3)| = 8$. Sign dhyan se!

Answer

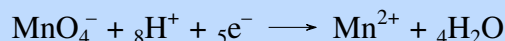
Option (4): 1 (N: $+5 \rightarrow -3$, 8 electrons needed, 4 Zn per NO_3^-)

Q12. Balanced: $\text{MnO}_4^- + \text{H}^+ + \text{C}_2\text{O}_4^{2-} \rightarrow \text{Mn}^{2+} + \text{CO}_2 + \text{H}_2\text{O}$. Moles of CO_2 ?

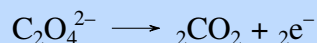
Explanation

Half-reactions:

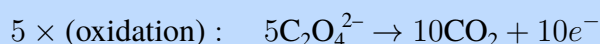
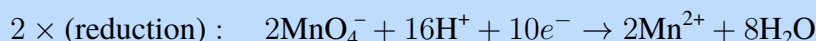
Reduction: Mn: $+7 \rightarrow +2$, $5e^-$ gained:



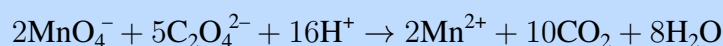
Oxidation: C in $\text{C}_2\text{O}_4^{2-}$: $+3 \rightarrow +4$ in CO_2 . Per $\text{C}_2\text{O}_4^{2-}$ (2 C atoms): $2e^-$ lost:



Balance electrons: $\text{LCM}(5, 2) = 10$.



Combined:



Moles of $\text{CO}_2 = 10$

Approach

Start: Mn: $5e^-$ (reduction). C in oxalate: $2e^-$ per $\text{C}_2\text{O}_4^{2-}$.

Middle: $\text{LCM}(5,2) = 10$. Multiply: 2 MnO_4^- and 5 $\text{C}_2\text{O}_4^{2-}$.

End: 5 $\text{C}_2\text{O}_4^{2-} \rightarrow 10 \text{CO}_2$. Answer = 10.

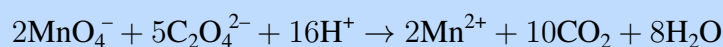
Answer

Option (3): 10 moles of CO_2

Q13 & Q14. Coefficients of MnO_4^- , $\text{C}_2\text{O}_4^{2-}$, H^+ in balanced equation?

Explanation

From Q12 balanced equation:



Coefficients: $\text{MnO}_4^- = 2$, $\text{C}_2\text{O}_4^{2-} = 5$, $\text{H}^+ = 16$

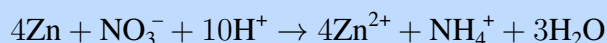
Answer

Q13: Option (1): 2, 5, 16 Q14: Option (2): 2, 5, 16

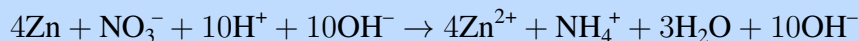
Q15 & Q16. Balanced: $\text{Zn} + \text{NO}_3^- \rightarrow \text{Zn}^{2+} + \text{NH}_4^+$ in BASIC medium. Coefficients of Zn, NO_3^- , OH^- ?

Explanation (Step-by-Step, Basic Medium)

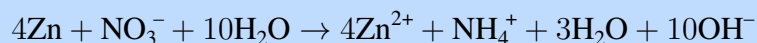
Step 1: Balance in acidic first (from Q11):



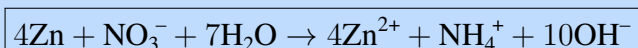
Step 2: Convert to basic medium — add 10 OH⁻ to both sides:



Step 3: 10H⁺ + 10OH⁻ = 10H₂O. Substitute:



Step 4: Simplify (cancel 3H₂O):



Coefficients: Zn = 4, NO₃⁻ = 1, OH⁻ = 10 (produced).

Approach

Start: Acidic mein balance karo (Q11 se: 4Zn + NO₃⁻ + 10H⁺...).

Middle: 10 OH⁻ add karo both sides.

End: H⁺ + OH⁻ = H₂O. Simplify. Get 4Zn + NO₃⁻ + 7H₂O → 4Zn²⁺ + NH₄⁺ + 10OH⁻.

Acidic to Basic Medium — Standard Method!

Yeh method hamesha kaam karta hai:

1. Acidic mein balance karo
2. H⁺ jitna hai utna OH⁻ dono sides add karo
3. H⁺ + OH⁻ = H₂O bana do
4. Simplify (cancel H₂O if repeated)

Answer

Q15: Option (3): 4, 1, 10 (Zn=4, NO₃⁻=1, OH⁻=10)

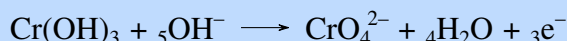
Q16: Option (3): 4Zn + NO₃⁻ + 7H₂O → 4Zn²⁺ + NH₄⁺ + 10OH⁻

Q17. $a\text{Cr}(\text{OH})_3 + b\text{IO}_3^- + c\text{OH}^- \rightarrow d\text{I}^- + a\text{CrO}_4^{2-} + e\text{H}_2\text{O}$. Ratio b:a?

Explanation (Step-by-Step)

Half-reactions:

Oxidation: Cr in $\text{Cr}(\text{OH})_3$: $+3 \rightarrow +6$ in CrO_4^{2-} , $3e^-$ per Cr:

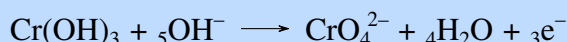


(Verify O: $3 + 5 = 8$ left; $4 + 4 = 8$ right . H: $3 + 5 = 8$ left; 8 right . Charge: $-1 - 5 = -6$ left; $-2 - 3 = -5$... hmm let me redo)

Actually: $\text{Cr}(\text{OH})_3 + \text{OH}^- \rightarrow \text{CrO}_4^{2-} + \text{H}_2\text{O} + 3e^-$

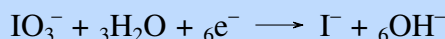
O: Left: $3+1=4$; Right: $4 + \text{H}_2\text{O}$. If we add more OH^- ...

Balanced oxidation half:



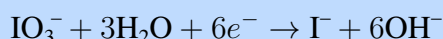
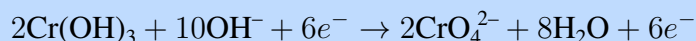
Check: O: $3 + 5 = 8$; $4 + 4 = 8$. H: $3 + 5 = 8$; 8 . Charge: $0 - 5 = -5$; $-2 - 3 = -5$

Reduction: I in IO_3^- : $+5 \rightarrow -1$, $6e^-$ per I:



Check: O: $3 + 3 = 6$; 6 . H: 6 ; 6 . Charge: $-1 - 6 = -7$; $-1 - 6 = -7$

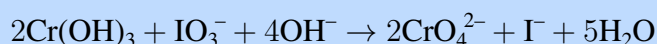
Balance electrons: $\text{LCM}(3,6)=6$. Multiply oxidation $\times 2$:



Combined (cancel $6e^-$):



Simplify:



So: $a = 2$, $b = 1$, $c = 4$, $d = 1$, $e = 5$.

Ratio $b : a = 1 : 2$.

Approach

Start: Cr($+3 \rightarrow +6$): $3e^-$ lost. I($+5 \rightarrow -1$): $6e^-$ gained. $\text{LCM}=6 \Rightarrow 2$ Cr per I.

End: $a = 2$ (Cr), $b = 1$ (IO_3^-). Ratio $b : a = 1 : 2 \Rightarrow$ Option (2).

Answer

Option (2): 1:2 ($b : a = 1 : 2$; per 2 $\text{Cr}(\text{OH})_3$, 1 IO_3^- needed)

Quick Reference — n-Factor & KMnO_4 in Different Media

Compound	Medium	n-factor	Product (Mn/Cr)
KMnO_4	Acidic (H^+)	5	Mn^{2+} (+7→+2)
KMnO_4	Neutral/Weak alkaline	3	MnO_2 (+7→+4)
KMnO_4	Strongly alkaline (OH^-)	1	MnO_4^{2-} (+7→+6)
$\text{K}_2\text{Cr}_2\text{O}_7$	Acidic	6	Cr^{3+} (2 Cr: +6→+3)

Equivalence Formula:

$$n_1 \times M_1 \times V_1 = n_2 \times M_2 \times V_2 \quad (n = \text{n-factor})$$

$$\text{Eq. Wt.} = \frac{MW}{n\text{-factor}} \quad \text{moles OA} \times n_{\text{OA}} = \text{moles RA} \times n_{\text{RA}}$$

TYPE-3 — n-Factor, Equivalent Weight & Oxidation State Change

Q18. n-factor of HCl in: $\text{K}_2\text{Cr}_2\text{O}_7 + \text{HCl} \rightarrow \text{KCl} + \text{CrCl}_3 + \text{Cl}_2 + \text{H}_2\text{O}$?

Explanation (Step-by-Step)

Step 1: Pehle equation balance karo:



Step 2: HCl ki do roles hain yahan:

- **Acid ki tarah (HCl ka H^+):** H^+ provide karta hai medium ke liye. IN: Cl stays -1 in K^+Cl^- aur $\text{Cr}^{3+}\text{Cl}_3^-$. No ON change. These HCl are **not** the reducing agent.
- **Reducing agent ki tarah:** $\text{Cl}^- (-1) \rightarrow \text{Cl}_2 (0) = \text{oxidized}$. Yeh 6 HCl hain ($3 \text{Cl}_2 = 6 \text{Cl}$ atoms).

Step 3: Total HCl = 14 molecules. Electrons transferred = 6 (from 6 Cl: $-1 \rightarrow 0$).

$$n\text{-factor of HCl} = \frac{\text{total electrons}}{\text{total HCl moles}} = \frac{6}{14} = \frac{3}{7}$$

Approach

Start: Balanced equation likho ($\text{K}_2\text{Cr}_2\text{O}_7 + 14\text{HCl} \dots$).

Middle: Kitna HCl oxidized hua? 6 HCl Cl_2 banane ke liye ($3 \times 2 \text{Cl}$ atoms). 6 electrons transferred.

End: n-factor = $6/14 = 3/7$. Option (2).

Common Mistake — n-factor kab 1 hota, kab 3/7?

Galti: Students sochte hain HCl ka n-factor = 1 (kyunki Cl $-1 \rightarrow 0$ change hota hai, per mole 1 electron).

Sahi: Yeh n-factor **effective n-factor** hai — total electrons / total moles. 14 HCl mein se sirf 6 oxidize hote hain. Effective $n = 6/14 = 3/7$.

Agar question sirf “HCl as reducing agent” pooche: $n = 1$. Lekin is question mein saare HCl ke liye average pooch raha hai!

Answer

Option (2): $\frac{3}{7}$ (6 electrons from 14 HCl = effective n-factor 3/7)

Q19. Equivalent weight of KMnO_4 in alkaline solution ($2\text{KMnO}_4 + 2\text{KOH} \rightarrow 2\text{K}_2\text{MnO}_4 + \text{H}_2\text{O} + \text{O}$)?

Explanation

Mn ka ON change:

- KMnO_4 : Mn = +7
- K_2MnO_4 : $2(+1) + Mn + 4(-2) = 0 \Rightarrow Mn = +6$
- Change: $+7 \rightarrow +6 = 1$ electron gained (reduction)

(Note: O in KOH: $-2 \rightarrow 0$ in O_2 — O is oxidized. This is the balancing act.)

n-factor of KMnO_4 in alkaline medium = 1

Molecular weight of KMnO_4 :

$$MW = 39 + 55 + 4(16) = 39 + 55 + 64 = 158 \text{ g/mol}$$

Equivalent weight:

$$E = \frac{MW}{n} = \frac{158}{1} = \mathbf{158.0 \text{ g/equiv}}$$

Approach

Start: Alkaline medium mein Mn: $+7 \rightarrow +6$. n-factor = 1.

End: Eq. wt. = $158/1 = 158.0$. Option (4).

KMnO_4 Equivalent Weight in Three Media — Must Memorize!

Medium	n-factor	Eq. Wt.
Acidic	5	$158/5 = \mathbf{31.6}$
Neutral	3	$158/3 = \mathbf{52.7}$
Alkaline	1	$158/1 = \mathbf{158.0}$

Teeno options mein yahi values diye hain! Medium dekho aur answer seedha lo.

Answer

Option (4): 158.0 (Alkaline medium, Mn: $+7 \rightarrow +6$, n-factor = 1, Eq. wt. = $158/1$)

Q20. SO_2 + acidified $\text{K}_2\text{Cr}_2\text{O}_7$. S ON changes from?

Explanation

- $\text{K}_2\text{Cr}_2\text{O}_7$: Strong oxidizing agent (Cr: $+6 \rightarrow +3$).
- SO_2 : S is $+4$ (acting as **reducing agent**).
- Reaction: $\text{K}_2\text{Cr}_2\text{O}_7 + 3\text{SO}_2 + \text{H}_2\text{SO}_4 \longrightarrow \text{K}_2\text{SO}_4 + \text{Cr}_2(\text{SO}_4)_3 + \text{H}_2\text{O}$
- S in SO_2 : $+4 \rightarrow$ S in $\text{K}_2\text{SO}_4 / \text{Cr}_2(\text{SO}_4)_3$: $+6$
- S: $+4 \rightarrow +6$ (oxidized by $\text{K}_2\text{Cr}_2\text{O}_7$)

Approach

$\text{K}_2\text{Cr}_2\text{O}_7 = \text{OA}$ (gets reduced). $\text{SO}_2 = \text{RA}$ (gets oxidized). S: $+4 \rightarrow +6$. Option (3).

Answer

Option (3): $+4$ to $+6$ (S in SO_2 oxidized to sulfate $+6$ by dichromate)

TYPE-4 — Mole Ratio & Stoichiometry Using Redox Equivalence

Q21. In $2\text{KMnO}_4 + 5\text{H}_2\text{S} + 6\text{H}^+ \rightarrow 2\text{Mn}^{2+} + 2\text{K}^+ + 5\text{S} + 8\text{H}_2\text{O}$. Electrons per mole of reductant?

Explanation

Reductant = H_2S (it gives electrons, gets oxidized).

S in H_2S : $-2 \rightarrow 0$ in S (elemental): change = 2 electrons per H_2S .

\therefore Per mole of reductant (H_2S) = **2 electrons** involved in oxidation.

Verify using equation: $5 \text{ mol } \text{H}_2\text{S} \times 2 e^-/\text{mol} = 10 e^-$ total. $2 \text{ mol } \text{KMnO}_4 \times 5 e^-/\text{mol} = 10 e^-$ total.

Approach

S: $-2 \rightarrow 0 = 2$ electrons per H_2S . Per mole of reductant = 2. Option (1) Two.

Answer

Option (1): Two (S: $-2 \rightarrow 0$, 2 electrons per H_2S)

Q22. Moles of KMnO_4 for 1 mole sulphite (SO_3^{2-}) in acidic solution? [AIPMT-2007]

Explanation (Step-by-Step)

Sulphite (SO_3^{2-}) ka ON:

- S in SO_3^{2-} : +4; S in SO_4^{2-} (product): +6
- n-factor of sulphite = 2 (S: +4 \rightarrow +6, 2 electrons per mole)

KMnO_4 acidic: n-factor = 5 (Mn: +7 \rightarrow +2)

Equivalence principle:

$$\text{mol}_{\text{KMnO}_4} \times 5 = \text{mol}_{\text{SO}_3^{2-}} \times 2$$

$$\text{mol}_{\text{KMnO}_4} = \frac{1 \times 2}{5} = \frac{2}{5} \text{ mol}$$

Approach

Start: $n(\text{SO}_3^{2-}) = 2$; $n(\text{KMnO}_4 \text{ acidic}) = 5$.

End: $\text{mol KMnO}_4 = 1 \times 2/5 = 2/5$. Option (4).

Answer

Option (4): $\frac{2}{5}$ mol KMnO_4

Q23 & Q24. Moles of KMnO_4 for 1 mole ferrous oxalate (FeC_2O_4) in acidic medium?

Explanation (Step-by-Step)

FeC_2O_4 mein do reducing species hain:

- Fe^{2+} : +2 \rightarrow +3 (oxidized, 1 electron per Fe)
- $\text{C}_2\text{O}_4^{2-}$: C is +3 \rightarrow +4 in CO_2 . 2 C atoms, so 2 electrons per oxalate

Total n-factor of $\text{FeC}_2\text{O}_4 = 1 + 2 = 3$

KMnO_4 acidic: n-factor = 5

Equivalence:

$$\text{mol KMnO}_4 \times 5 = 1 \times 3$$

$$\text{mol KMnO}_4 = \frac{3}{5} \text{ mol} = 0.6 \text{ mol}$$

Approach

Start: FeC_2O_4 has Fe^{2+} ($1e^-$) + $\text{C}_2\text{O}_4^{2-}$ ($2e^-$) = total $3e^-$.

End: $\text{mol KMnO}_4 = 3/5 = 0.6$.

Common Mistake — FeC_2O_4 Mein DONO Species Oxidize Hoti Hain!

Students sirf Fe^{2+} ($1e^-$) count karte hain, $\text{C}_2\text{O}_4^{2-}$ bhool jaate hain. **GALAT!** KMnO_4 acidic mein dono Fe^{2+} aur $\text{C}_2\text{O}_4^{2-}$ oxidize hoti hain. Total n-factor = $1+2 = 3$, not 1.

Answer

Q23: Option (3): $\frac{3}{5}$ **Q24: Option (3): 0.6 moles**

Q25. Moles of FeSO₄ reacted with 1 mole KMnO₄ in acidic medium?**Explanation**

- FeSO₄: Fe²⁺ is reducing species. S in SO₄²⁻ is +6 (can't be further oxidized). n-factor = 1.
- KMnO₄ acidic: n-factor = 5.

Equivalence:

$$\begin{aligned} \text{mol FeSO}_4 \times 1 &= 1 \times 5 \\ \text{mol FeSO}_4 &= 5 \end{aligned}$$

Approach

FeSO₄ n=1; KMnO₄ n=5. mol FeSO₄ = 1×5/1 = 5. Option (2).

Answer

Option (2): 5 moles FeSO₄ per 1 mole KMnO₄

Q26. Same moles of which compound needs LEAST acidified KMnO₄?**Explanation (Compare n-factors)**

Least KMnO₄ ⇒ Least electrons donated per mole ⇒ Smallest n-factor.

Calculate n-factor for each compound:

Compound	Reducing Species	n-factor	mol KMnO ₄ needed
(1) FeC ₂ O ₄	Fe ²⁺ (1e ⁻) + C ₂ O ₄ ²⁻ (2e ⁻)	3	3/5
(2) Fe(NO ₃) ₂	Fe ²⁺ (1e ⁻) only; NO ₃ ⁻ N=+5 (max!)	1	1/5
(3) FeSO ₄	Fe ²⁺ (1e ⁻) only; SO ₄ ²⁻ S=+6 (max!)	1	1/5
(4) FeSO ₃	Fe ²⁺ (1e ⁻) + SO ₃ ²⁻ (2e ⁻ , S:+4→+6)	3	3/5

Fe(NO₃)₂ aur FeSO₄ dono 1/5 mol KMnO₄ chahiye (tied). Standard exam answer: **Fe(NO₃)₂**.

Key Insight**Anion ka role:**

- NO₃⁻ mein N = +5 (HIGHEST for N) ⇒ Cannot be further oxidized ⇒ n = 0 (anion contributes nothing)
- SO₄²⁻ mein S = +6 (HIGHEST for S) ⇒ Same, n = 0
- C₂O₄²⁻ mein C = +3 (CAN go to +4) ⇒ n = 2
- SO₃²⁻ mein S = +4 (CAN go to +6) ⇒ n = 2

Approach

Start: Har compound mein oxidizable species dhundho. n-factor nikalo.

End: Smallest n-factor ⇒ Least KMnO₄. Fe(NO₃)₂ and FeSO₄ both = 1. Standard answer: Option (2).

Answer

Option (2): Fe(NO₃)₂ (n-factor = 1, needs least KMnO₄ = 1/5 mol per mol compound)

Q27. 2g FeSO₄ + 0.05 M KMnO₄ (acidic). Volume needed? (Fe=56, S=32, O=16)

Explanation (Step-by-Step)

Step 1: MW of FeSO₄:

$$MW = 56 + 32 + 4 \times 16 = 56 + 32 + 64 = 152 \text{ g/mol}$$

Step 2: Moles of FeSO₄:

$$n_{\text{FeSO}_4} = \frac{2}{152} \text{ mol}$$

Step 3: n-factors:

- FeSO₄: n = 1 (Fe²⁺ → Fe³⁺)
- KMnO₄ acidic: n = 5

Step 4: Equivalence principle:

$$\begin{aligned}n_1 M_1 V_1 &= n_2 \times \text{mol}_2 \\5 \times 0.05 \times V &= \frac{2}{152} \times 1 \\0.25V &= \frac{2}{152} \\V &= \frac{2}{152 \times 0.25} = \frac{2}{38} = \frac{1}{19} \approx 0.0526 \text{ L}\end{aligned}$$

Closest option: 0.05 L

(Note: Slight discrepancy because question uses MW = 160 approximately in answer key, giving exact 0.05 L. With MW = 152: exact answer ≈ 52.6 mL ≈ 0.05 L)

Approach

Start: MW(FeSO₄) = 152. Moles = 2/152. n-factor FeSO₄ = 1, KMnO₄ = 5.

Middle: Equivalence: $5 \times 0.05 \times V = (2/152) \times 1$.

End: $V = 2/38 \approx 0.053 \text{ L} \approx \mathbf{0.05 \text{ L}}$ (Option 2).

Common Mistakes in Numericals!

Mistake 1: MW(FeSO₄) galat nikalna. Always: Fe + S + 4O = 56 + 32 + 64 = 152.

Mistake 2: n-factor of KMnO₄ = 5 use karna acidic medium mein (CORRECT!). Alkaline mein n=1 hai.

Mistake 3: Volume moles se divide karna, molarity se nahi. **V = moles / Molarity.**

Shortcut check: $n_{\text{OA}} \times M_{\text{OA}} \times V = n_{\text{RA}} \times \text{moles}_{\text{RA}}$.

Answer

Option (2): ≈ 0.05 L (V = 2/(38) ≈ 52.6 mL ≈ 0.05 L)

DPP-5 Summary — Key Formulas for Quick Revision

Concept	Formula / Key Point
Electrons in half-reaction	$\Delta ON \times \text{atoms} = \text{electrons}$
n-factor (acid) KMnO_4	5 (Mn: $+7 \rightarrow +2$)
n-factor (neutral) KMnO_4	3 (Mn: $+7 \rightarrow +4$)
n-factor (alkaline) KMnO_4	1 (Mn: $+7 \rightarrow +6$)
Eq. wt. =	MW / n-factor
Equivalence	$\text{mol}_1 \times n_1 = \text{mol}_2 \times n_2$
FeC_2O_4 n-factor	3 ($\text{Fe}^{2+} = 1 + \text{C}_2\text{O}_4^{2-} = 2$)
FeSO_4 n-factor	1 (only Fe^{2+})
Basic medium conversion	Add OH^- both sides, neutralize H^+