

UNIT 8

REDOX REACTIONS

ANSWERS

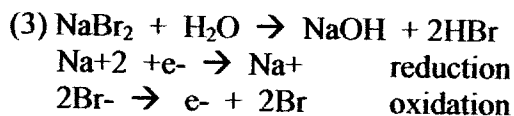
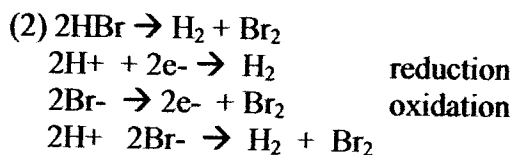
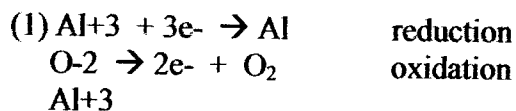
Rules for Assigning Oxidation Numbers

Exercise: Assign oxidation numbers to the atoms in the following species:

HCl H \rightarrow +1 Cl \rightarrow -1	LiH Li \rightarrow +1 H \rightarrow -1	HClO ₃ H \rightarrow +1 Cl \rightarrow +5 O \rightarrow -2	H ₃ PO ₄ H \rightarrow +1 P \rightarrow +7 O \rightarrow -2	H ₂ O H \rightarrow +1 O \rightarrow -2
H ₂ O ₂ H \rightarrow +1 O \rightarrow -1	CaO Ca \rightarrow +2 O \rightarrow -2	CaF ₂ Ca \rightarrow +2 F \rightarrow -1	NO ₃ ⁻ N \rightarrow +5 O \rightarrow -2	S ₂ O ₃ ⁻² S \rightarrow +2 O \rightarrow -2
Cl ⁻ Cl \rightarrow -1	ClO ⁻ Cl \rightarrow +1 O \rightarrow -2	ClO ₂ ⁻ Cl \rightarrow +3 O \rightarrow -2	ClO ₃ ⁻ Cl \rightarrow +5 O \rightarrow -2	ClO ₄ ⁻ Cl \rightarrow +7 O \rightarrow -2

Redox Half-Reactions

Assignment



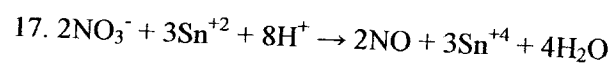
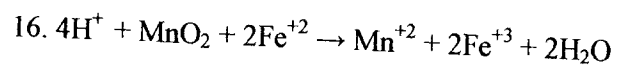
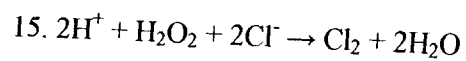
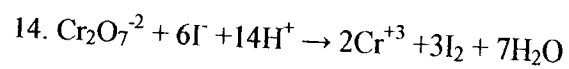
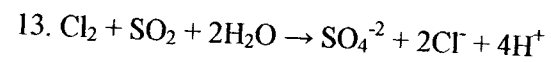
Balancing Redox Equations

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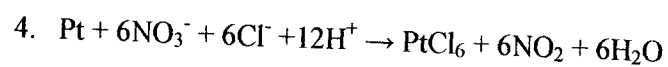
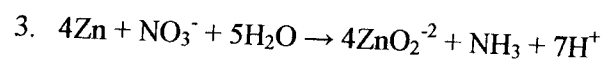
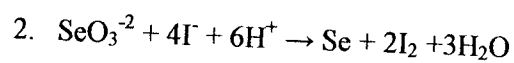
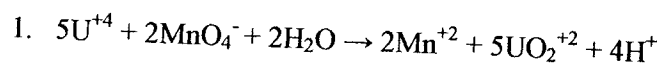
1. $3\text{CuO} + 2\text{NH}_3 \rightarrow 3\text{Cu} + \text{N}_2 + 3\text{H}_2\text{O}$
2. $10\text{HNO}_3 + \text{I}_2 \rightarrow 2\text{HIO}_3 + 10\text{NO}_2 + 4\text{H}_2\text{O}$
3. $3\text{H}_2\text{S} + 2\text{HNO}_3 \rightarrow 3\text{S} + 2\text{NO} + 4\text{H}_2\text{O}$
4. $2\text{KMnO}_4 + 10\text{FeSO}_4 + 8\text{H}_2\text{SO}_4 \rightarrow \text{K}_2\text{SO}_4 + 2\text{MnSO}_4 + 8\text{H}_2\text{O} + 5\text{Fe}_2(\text{SO}_4)_3$
5. $\text{K}_2\text{Cr}_2\text{O}_7 + 6\text{HI} + 8\text{HCl} \rightarrow 2\text{KCl} + 2\text{CrCl}_3 + 3\text{I}_2 + 7\text{H}_2\text{O}$
6. $8\text{Al} + 3\text{NaNO}_3 + 5\text{NaOH} + 18\text{H}_2\text{O} \rightarrow 3\text{NH}_3 + 8\text{NaAl}(\text{OH})_4$
7. $3\text{CuS} + 8\text{HNO}_3 \rightarrow 3\text{Cu}(\text{NO}_3)_2 + 3\text{S} + 2\text{NO} + 4\text{H}_2\text{O}$
8. $2\text{MnSO}_4 + 5\text{PbO}_2 + 3\text{H}_2\text{SO}_4 \rightarrow 2\text{HMnO}_4 + 5\text{PbSO}_4 + 2\text{H}_2\text{O}$
9. $3\text{P}_4 + 20\text{HNO}_3 + 8\text{H}_2\text{O} \rightarrow 12\text{H}_3\text{PO}_4 + 20\text{NO}$
10. $2\text{KMnO}_4 + 5\text{H}_2\text{O}_2 + 6\text{HCl} \rightarrow 2\text{MnCl}_2 + 2\text{KCl} + 5\text{O}_2 + 8\text{H}_2\text{O}$

Extra Balancing Equations: Redox

1. $5\text{Co} + 2\text{MnO}_4^- + 16\text{H}^+ \rightarrow 5\text{Co}^{+2} + 2\text{Mn}^{+2} + 8\text{H}_2\text{O}$
2. $\text{Cl}_2 + 2\text{OH}^- \rightarrow \text{ClO}^- + \text{Cl}^- + \text{H}_2\text{O}$
3. $5\text{I}^- + \text{IO}_3^- + 6\text{H}^+ \rightarrow 3\text{I}_2 + 3\text{H}_2\text{O}$
4. $\text{CrO}_7^{2-} + 3\text{SO}_3^{2-} + 8\text{H}^+ \rightarrow 2\text{Cr}^{+3} + 3\text{SO}_4^{2-} + 4\text{H}_2\text{O}$
5. $\text{I}_2 + 5\text{Cl}_2 + 6\text{H}_2\text{O} \rightarrow 2\text{IO}_3^- + 10\text{Cl}^- + 12\text{H}^+$
6. $14\text{H}^+ + 3\text{S}^{2-} + \text{Cr}_2\text{O}_7^{2-} \rightarrow 3\text{S} + 2\text{Cr}^{+3} + 7\text{H}_2\text{O}$
7. $\text{S}^{2-} + 6\text{NO}_3^- + 8\text{H}^+ \rightarrow \text{SO}_2 + 6\text{NO}_2 + 4\text{H}_2\text{O}$
8. $2\text{H}_2\text{O}_2 \rightarrow \text{O}_2 + 2\text{H}_2\text{O}$
9. $3\text{Fe}_3\text{O}_4 + 8\text{Al} \rightarrow 9\text{Fe} + 4\text{Al}_2\text{O}_3$
10. $\text{Cu} + 2\text{NO}_3^- + 4\text{H}^+ \rightarrow \text{Cu}^{+2} + 2\text{NO}_2^- + 2\text{H}_2\text{O}$
11. $5\text{Fe}^{+2} + \text{MnO}_4^- + 8\text{H}^+ \rightarrow 5\text{Fe}^{+3} + \text{Mn}^{+2} + 4\text{H}_2\text{O}$
12. $\text{H}_2\text{S} + 2\text{NO}_3^- + 2\text{H}^+ \rightarrow \text{S} + 2\text{NO}_2 + 2\text{H}_2\text{O}$



Others:

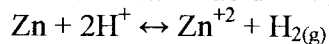


Predict whether the following are likely to react.

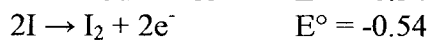
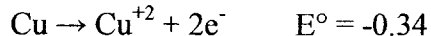
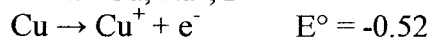
Write equations only where you predict a reaction will be likely

Part A

1. metal + acid \rightarrow hydrogen

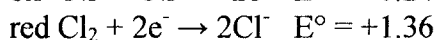
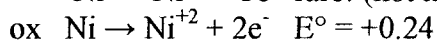
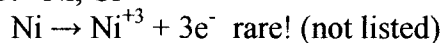


2. Cu, Na⁺, I⁻

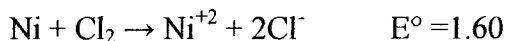


All -ve therefore no reaction

3. Ni, Cl



+ve E°



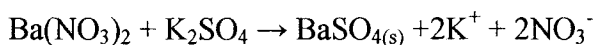
4. Mg⁺², NO₃⁻, Na⁺, OH⁻

K_{sp} of Mg(NO₃)₂ is 5.6×10^{-12} so this ppt will form

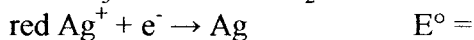
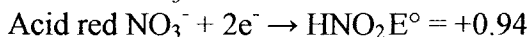
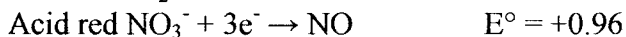


5. Ba⁺², NO₃⁻, K⁺, SO₄⁻²

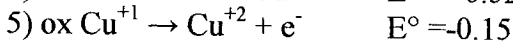
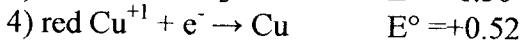
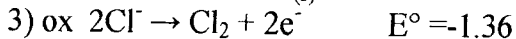
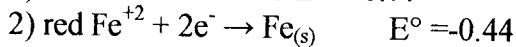
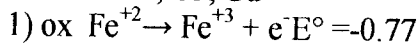
K_{sp} of BaSO₄ is 1.1×10^{-10} so this ppt will form



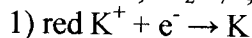
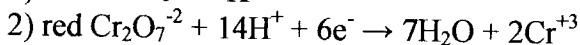
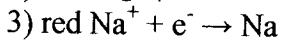
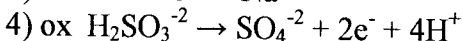
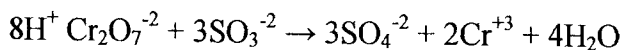
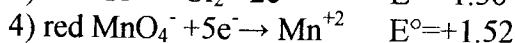
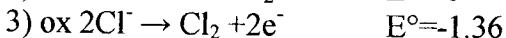
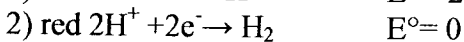
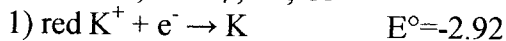
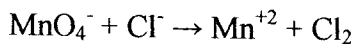
6. Cl₂, NO₃⁻, Ag⁺



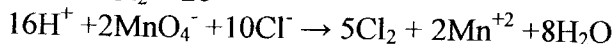
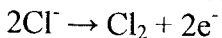
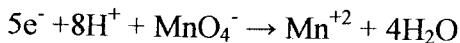
All Red reactions therefore no reaction occurs

Part B1. $\text{Fe}^{+2}, \text{Cl}^-, \text{Cu}^{+1}$ 1,2 (2 irons \rightarrow NR)4,1 $\rightarrow E^\circ$ is neg. \rightarrow NR2,3 $\rightarrow E^\circ$ is neg. \rightarrow NR4,3 $\rightarrow E^\circ$ is neg. \rightarrow NR2,5 $\rightarrow E^\circ$ is neg. \rightarrow NR4,5 \rightarrow 2 coppers \rightarrow NR

Therefore no reaction occurs

2. $\text{K}^+, \text{Cr}_2\text{O}_7^{-2}, \text{Na}^+, \text{SO}_3^{-2}$  $E^\circ = -2.92$  $E^\circ = +1.33$  $E^\circ = -2.71$  $E^\circ = -0.17$ acid1,4 $\rightarrow E^\circ$ is neg. \rightarrow NR2,4 $\rightarrow E^\circ$ is pos. \rightarrow r*n3,4 $\rightarrow E^\circ$ is neg. \rightarrow NR3. $\text{Zn}^{+2}, \text{SO}_4^{-2}, \text{NH}_4^+, \text{CO}_3^{-2}$ ZnCO_3 has $K_{sp} = 1.2 \times 10^{-10}$ so a ppt will form4. Again AgCl ($k_{sp} = 1.86 \times 10^{-10}$) will form5. $\text{K}^+, \text{MnO}_4^-, \text{H}^+, \text{Cl}^-$ 3,1 $\rightarrow E^\circ$ is neg. \rightarrow NR3,2 $\rightarrow E^\circ$ is neg. \rightarrow NR3,4 $\rightarrow E^\circ$ is pos. \rightarrow r*n

Balance



6. Cu, Fe⁺³, Cl⁻

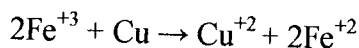
- | | |
|---|----------------------------------|
| 1) ox Cu → Cu ⁺ + e ⁻ | E° = -0.52 |
| 2) ox Cu → Cu ⁺² + 2e ⁻ | E° = -0.34 |
| 3) red Fe ⁺³ + e ⁻ → Fe ⁺² | E° = +0.77 |
| 4) red Fe ⁺³ + 3e ⁻ → Fe | E° = successive steps E° = +0.33 |
| 5) ox 2Cl ⁻ → Cl ₂ + 2e ⁻ | E° = -1.36 |

3,1 → is pos. → r*n E° = 0.25

3,2 → is pos. → r*n E° = 0.43

3,5 → is neg. → NR

The E° is like a K_{eq} and determines how far a reaction proceeds thus E° = 0.43 is the dominant reaction.

7. K⁺, Br⁻, Fe⁺³, Cl⁻

- | | |
|---|------------|
| 1) red K ⁺ + e ⁻ → K | E° = -2.92 |
| 2) ox 2Br ⁻ → Br ₂ + 2e ⁻ | E° = -1.06 |
| 3) ox 2Cl ⁻ → Cl ₂ + 2e ⁻ | E° = -1.36 |
| 4) red Fe ⁺³ + e ⁻ → Fe ⁺² | E° = +0.77 |
| 5) red Fe ⁺³ + 3e ⁻ → Fe | E° = +0.33 |

2,1 → is neg. → NR

3,1 → is neg. → NR

2,4 → is neg. → NR

3,4 → is neg. → NR

2,5 → is neg. → NR

3,5 → is neg. → NR

No reaction

8. Fe⁺², SO₄⁻², K⁺, MnO₄⁻

- | | |
|---|------------|
| 1) red K ⁺ + e ⁻ → K | E° = -2.92 |
| 2) red MnO ₄ ⁻ + 5e ⁻ → Mn ⁺² | E° = +1.52 |
| 3) ox SO ₄ ⁻² → S ₂ O ₈ ⁻² + 2e ⁻ | E° = -2.05 |
| 4) red SO ₄ ⁻² + 2e ⁻ → H ₂ SO ₃ | E° = +0.17 |
| 5) red Fe ⁺² + 2e ⁻ → Fe _(s) | E° = -0.44 |
| 6) ox Fe ⁺² → Fe ⁺³ + e ⁻ | E° = -0.77 |

3,1 → is neg → NR

6,1 → is neg → NR

3,2 → is neg → NR

6,2 → is pos → r*n E° = +0.75

3,4 → is neg → NR

6,3 → is neg → NR

3,5 → is neg → NR

6,5 → is neg → NR

