

UNIT 8

REDOX REACTIONS

ANSWERS

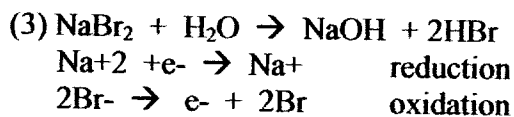
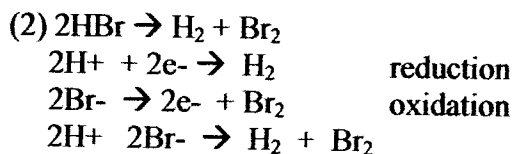
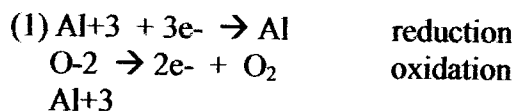
Rules for Assigning Oxidation Numbers

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



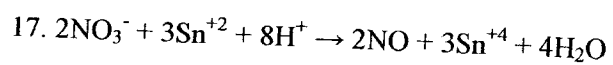
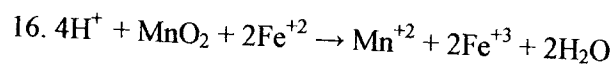
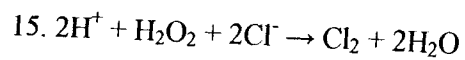
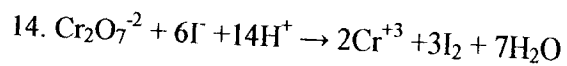
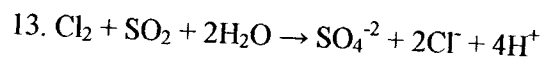
Balancing Redox Equations

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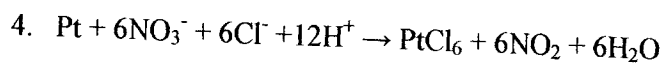
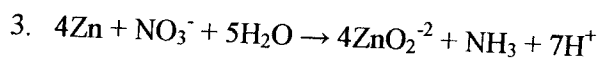
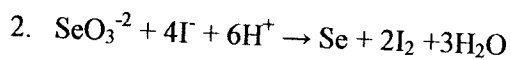
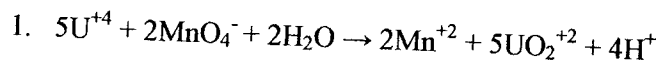
1. $3\text{CuO} + 2\text{NH}_3 \rightarrow 3\text{Cu} + \text{N}_2 + 3\text{H}_2\text{O}$
2. $10\text{HNO}_3 + \text{I}_2 \rightarrow 2\text{HIO}_3 + 10\text{NO}_2 + 4\text{H}_2\text{O}$
3. $3\text{H}_2\text{S} + 2\text{HNO}_3 \rightarrow 3\text{S} + 2\text{NO} + 4\text{H}_2\text{O}$
4. $2\text{KMnO}_4 + 10\text{FeSO}_4 + 8\text{H}_2\text{SO}_4 \rightarrow \text{K}_2\text{SO}_4 + 2\text{MnSO}_4 + 8\text{H}_2\text{O} + 5\text{Fe}_2(\text{SO}_4)_3$
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:

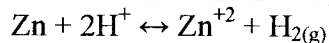


Predict whether the following are likely to react.

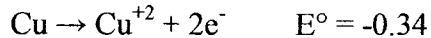
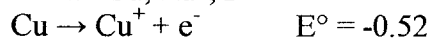
Write equations only where you predict a reaction will be likely

Part A

1. metal + acid $\rightarrow$ hydrogen

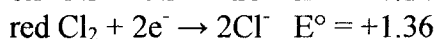
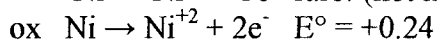
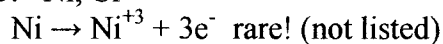


2. Cu, Na⁺, I⁻

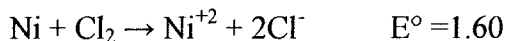


All -ve therefore no reaction

3. Ni, Cl



+ve E°



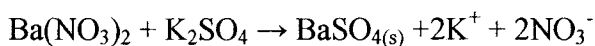
4. Mg⁺², NO₃⁻, Na⁺, OH⁻

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

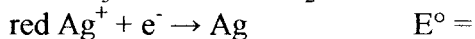
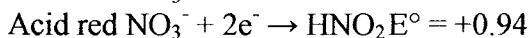
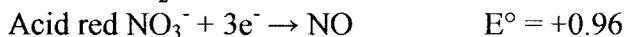


5. Ba⁺², NO₃⁻, K⁺, SO₄⁻²

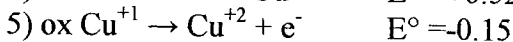
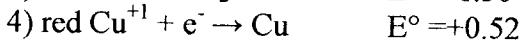
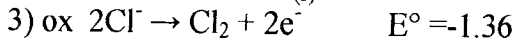
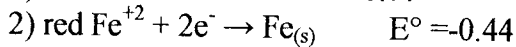
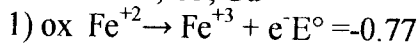
K_{sp} of BaSO₄ is 1.1×10^{-10} so this ppt will form



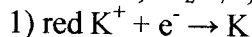
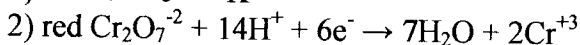
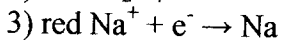
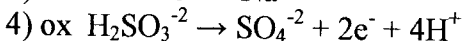
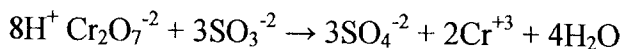
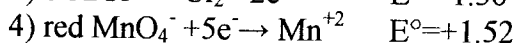
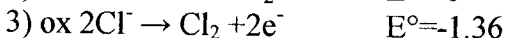
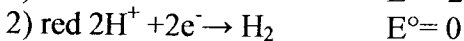
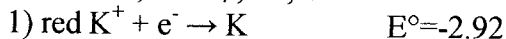
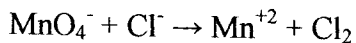
6. Cl₂, NO₃⁻, Ag⁺



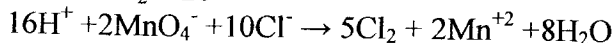
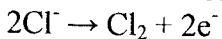
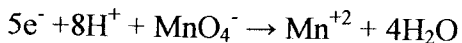
All Red reactions therefore no reaction occurs

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. $\text{Cu}, \text{Fe}^{+3}, \text{Cl}^-$

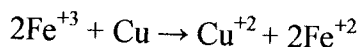
- 1) ox $\text{Cu} \rightarrow \text{Cu}^+ + \text{e}^-$ $E^\circ = -0.52$
- 2) ox $\text{Cu} \rightarrow \text{Cu}^{+2} + 2\text{e}^-$ $E^\circ = -0.34$
- 3) red $\text{Fe}^{+3} + \text{e}^- \rightarrow \text{Fe}^{+2}$ $E^\circ = +0.77$
- 4) red $\text{Fe}^{+3} + 3\text{e}^- \rightarrow \text{Fe}$ $E^\circ = \text{successive steps } E^\circ = +0.33$
- 5) ox $2\text{Cl}^- \rightarrow \text{Cl}_2 + 2\text{e}^-$ $E^\circ = -1.36$

3,1 $\rightarrow$ is pos. $\rightarrow r*n$ $E^\circ = 0.25$

3,2 $\rightarrow$ is pos. $\rightarrow r*n$ $E^\circ = 0.43$

3,5 $\rightarrow$ is neg. $\rightarrow \text{NR}$

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

7. $\text{K}^+, \text{Br}^-, \text{Fe}^{+3}, \text{Cl}^-$

- 1) red $\text{K}^+ + \text{e}^- \rightarrow \text{K}$ $E^\circ = -2.92$
- 2) ox $2\text{Br}^- \rightarrow \text{Br}_2 + 2\text{e}^-$ $E^\circ = -1.06$
- 3) ox $2\text{Cl}^- \rightarrow \text{Cl}_2 + 2\text{e}^-$ $E^\circ = -1.36$
- 4) red $\text{Fe}^{+3} + \text{e}^- \rightarrow \text{Fe}^{+2}$ $E^\circ = +0.77$
- 5) red $\text{Fe}^{+3} + 3\text{e}^- \rightarrow \text{Fe}$ $E^\circ = +0.33$

2,1 $\rightarrow$ is neg. $\rightarrow \text{NR}$

3,1 $\rightarrow$ is neg. $\rightarrow \text{NR}$

2,4 $\rightarrow$ is neg. $\rightarrow \text{NR}$

3,4 $\rightarrow$ is neg. $\rightarrow \text{NR}$

2,5 $\rightarrow$ is neg. $\rightarrow \text{NR}$

3,5 $\rightarrow$ is neg. $\rightarrow \text{NR}$

No reaction

8. $\text{Fe}^{+2}, \text{SO}_4^{-2}, \text{K}^+, \text{MnO}_4^-$

- 1) red $\text{K}^+ + \text{e}^- \rightarrow \text{K}$ $E^\circ = -2.92$
- 2) red $\text{MnO}_4^- + 5\text{e}^- \rightarrow \text{Mn}^{+2}$ $E^\circ = +1.52$
- 3) ox $\text{SO}_4^{-2} \rightarrow \text{S}_2\text{O}_8^{-2} + 2\text{e}^-$ $E^\circ = -2.05$
- 4) red $\text{SO}_4^{-2} + 2\text{e}^- \rightarrow \text{H}_2\text{SO}_3$ $E^\circ = +0.17$
- 5) red $\text{Fe}^{+2} + 2\text{e}^- \rightarrow \text{Fe}_{(\text{s})}$ $E^\circ = -0.44$
- 6) ox $\text{Fe}^{+2} \rightarrow \text{Fe}^{+3} + \text{e}^-$ $E^\circ = -0.77$

3,1 $\rightarrow$ is neg $\rightarrow \text{NR}$

6,1 $\rightarrow$ is neg $\rightarrow \text{NR}$

3,2 $\rightarrow$ is neg $\rightarrow \text{NR}$

6,2 $\rightarrow$ is pos $\rightarrow r*n$ $E^\circ = +0.75$

3,4 $\rightarrow$ is neg $\rightarrow \text{NR}$

6,3 $\rightarrow$ is neg $\rightarrow \text{NR}$

3,5 $\rightarrow$ is neg $\rightarrow \text{NR}$

6,5 $\rightarrow$ is neg $\rightarrow \text{NR}$

