

Practice Problems for Balancing Redox Equations in Acid/Base

Ion-electron Method (Scroll down for Oxidation Number/Balancing Electrons Method)

Redox Reactions in Acidic Solution:

- $\text{I}^-(\text{aq}) + \text{ClO}^-(\text{aq}) \rightarrow \text{I}_3^-(\text{aq}) + \text{Cl}^-(\text{aq})$
Oxidation: $3 \text{I}^-(\text{aq}) \rightarrow \text{I}_3^-(\text{aq}) + 2 \text{e}^-$
Reduction: $2 \text{e}^- + 2 \text{H}^+(\text{aq}) + \text{ClO}^- \rightarrow \text{Cl}^-(\text{aq}) + \text{H}_2\text{O}(\text{l})$
Overall: $2 \text{H}^+(\text{aq}) + 3 \text{I}^-(\text{aq}) + \text{ClO}^-(\text{aq}) \rightarrow \text{I}_3^-(\text{aq}) + \text{Cl}^-(\text{aq}) + \text{H}_2\text{O}(\text{l})$
- $\text{As}_2\text{O}_3(\text{s}) + \text{NO}_3^-(\text{aq}) \rightarrow \text{H}_3\text{AsO}_4(\text{aq}) + \text{NO}(\text{g})$
Oxidation: $[5 \text{H}_2\text{O}(\text{l}) + \text{As}_2\text{O}_3(\text{s}) \rightarrow 2 \text{H}_3\text{AsO}_4(\text{aq}) + 4 \text{H}^+(\text{aq}) + 4 \text{e}^-] \times 3$
Reduction: $[3 \text{e}^- + 4 \text{H}^+(\text{aq}) + \text{NO}_3^-(\text{aq}) \rightarrow \text{NO}(\text{g}) + 2 \text{H}_2\text{O}(\text{l})] \times 4$
Overall: $7 \text{H}_2\text{O}(\text{l}) + 4 \text{H}^+(\text{aq}) + 3 \text{As}_2\text{O}_3(\text{s}) + 4 \text{NO}_3^-(\text{aq}) \rightarrow 6 \text{H}_3\text{AsO}_4(\text{aq}) + 4 \text{NO}(\text{g})$
- $\text{Br}^-(\text{aq}) + \text{MnO}_4^-(\text{aq}) \rightarrow \text{Br}_2(\text{l}) + \text{Mn}^{2+}(\text{aq})$
Oxidation: $[2 \text{Br}^-(\text{aq}) \rightarrow \text{Br}_2(\text{l}) + 2 \text{e}^-] \times 5$
Reduction: $[5 \text{e}^- + 8 \text{H}^+(\text{aq}) + \text{MnO}_4^-(\text{aq}) \rightarrow \text{Mn}^{2+}(\text{aq}) + 4 \text{H}_2\text{O}(\text{l})] \times 2$
Overall: $16 \text{H}^+(\text{aq}) + 10 \text{Br}^-(\text{aq}) + 2 \text{MnO}_4^-(\text{aq}) \rightarrow 5 \text{Br}_2(\text{l}) + 2 \text{Mn}^{2+}(\text{aq}) + 8 \text{H}_2\text{O}(\text{l})$
- $\text{CH}_3\text{OH}(\text{aq}) + \text{Cr}_2\text{O}_7^{2-}(\text{aq}) \rightarrow \text{CH}_2\text{O}(\text{l}) + \text{Cr}^{3+}(\text{aq})$
Oxidation: $[\text{CH}_3\text{OH}(\text{aq}) \rightarrow \text{CH}_2\text{O}(\text{l}) + 2 \text{H}^+(\text{aq}) + 2 \text{e}^-] \times 3$
Reduction: $[6 \text{e}^- + 14 \text{H}^+(\text{aq}) + \text{Cr}_2\text{O}_7^{2-}(\text{aq}) \rightarrow 2 \text{Cr}^{3+}(\text{aq}) + 7 \text{H}_2\text{O}(\text{l})] \times 4$
Overall: $8 \text{H}^+(\text{aq}) + 3 \text{CH}_3\text{OH}(\text{aq}) + \text{Cr}_2\text{O}_7^{2-}(\text{aq}) \rightarrow 3 \text{CH}_2\text{O}(\text{l}) + 2 \text{Cr}^{3+}(\text{aq}) + 7 \text{H}_2\text{O}(\text{l})$
- $\text{Mn}^{2+}(\text{aq}) + \text{BiO}_3^-(\text{aq}) \rightarrow \text{Bi}^{3+}(\text{aq}) + \text{MnO}_4^-(\text{aq})$
Oxidation: $[4 \text{H}_2\text{O}(\text{l}) + \text{Mn}^{2+}(\text{aq}) \rightarrow \text{MnO}_4^-(\text{aq}) + 8 \text{H}^+(\text{aq}) + 5 \text{e}^-] \times 2$
Reduction: $[2 \text{e}^- + 6 \text{H}^+(\text{aq}) + \text{BiO}_3^-(\text{aq}) \rightarrow \text{Bi}^{3+}(\text{aq}) + 3 \text{H}_2\text{O}(\text{l})] \times 5$
Overall: $14 \text{H}^+(\text{aq}) + 2 \text{Mn}^{2+}(\text{aq}) + 5 \text{BiO}_3^-(\text{aq}) \rightarrow 2 \text{MnO}_4^-(\text{aq}) + 5 \text{Bi}^{3+}(\text{aq}) + 7 \text{H}_2\text{O}(\text{l})$
- $\text{S}_8(\text{s}) + \text{NO}_3^-(\text{aq}) \rightarrow \text{SO}_3^{2-}(\text{aq}) + \text{NO}(\text{g})$
Oxidation: $[24 \text{H}_2\text{O}(\text{l}) + \text{S}_8(\text{s}) \rightarrow 8 \text{SO}_3^{2-}(\text{aq}) + 48 \text{H}^+(\text{aq}) + 32 \text{e}^-] \times 3$
Reduction: $[3 \text{e}^- + 4 \text{H}^+(\text{aq}) + \text{NO}_3^-(\text{aq}) \rightarrow \text{NO}(\text{g}) + 2 \text{H}_2\text{O}(\text{l})] \times 32$
Overall: $8 \text{H}_2\text{O}(\text{l}) + 3 \text{S}_8(\text{s}) + 32 \text{NO}_3^-(\text{aq}) \rightarrow 24 \text{SO}_3^{2-}(\text{aq}) + 32 \text{NO}(\text{g}) + 16 \text{H}^+(\text{aq})$
- $\text{H}_3\text{AsO}_4(\text{aq}) + \text{Zn}(\text{s}) \rightarrow \text{AsH}_3(\text{g}) + \text{Zn}^{2+}(\text{aq})$
Oxidation: $[\text{Zn}(\text{s}) \rightarrow \text{Zn}^{2+}(\text{aq}) + 2 \text{e}^-] \times 4$
Reduction: $[8 \text{e}^- + 8 \text{H}^+(\text{aq}) + \text{H}_3\text{AsO}_4(\text{aq}) \rightarrow \text{AsH}_3(\text{g}) + 4 \text{H}_2\text{O}(\text{l})]$
Overall: $8 \text{H}^+(\text{aq}) + \text{H}_3\text{AsO}_4(\text{aq}) + 4 \text{Zn}(\text{s}) \rightarrow \text{AsH}_3(\text{g}) + 4 \text{Zn}^{2+}(\text{aq}) + 4 \text{H}_2\text{O}(\text{l})$
- $\text{P}_4(\text{s}) + \text{Cr}_2\text{O}_7^{2-}(\text{aq}) \rightarrow \text{H}_3\text{PO}_4(\text{aq}) + \text{Cr}^{3+}(\text{aq})$
Oxidation: $[16 \text{H}_2\text{O}(\text{l}) + \text{P}_4(\text{s}) \rightarrow 4 \text{H}_3\text{PO}_4(\text{aq}) + 20 \text{H}^+(\text{aq}) + 20 \text{e}^-] \times 3$
Reduction: $[6 \text{e}^- + 14 \text{H}^+(\text{aq}) + \text{Cr}_2\text{O}_7^{2-}(\text{aq}) \rightarrow 2 \text{Cr}^{3+}(\text{aq}) + 7 \text{H}_2\text{O}(\text{l})] \times 10$
Overall: $80 \text{H}^+(\text{aq}) + 3 \text{P}_4(\text{s}) + 10 \text{Cr}_2\text{O}_7^{2-}(\text{aq}) \rightarrow 12 \text{H}_3\text{PO}_4(\text{aq}) + 20 \text{Cr}^{3+}(\text{aq}) + 22 \text{H}_2\text{O}(\text{l})$

Redox Reactions in Basic Solution

- $$\text{Al(s)} + \text{MnO}_4^-(\text{aq}) \rightarrow \text{MnO}_2(\text{s}) + \text{Al(OH)}_4^-(\text{aq})$$

Oxidation: $4 \text{H}_2\text{O(l)} + \text{Al(s)} \rightarrow \text{Al(OH)}_4^-(\text{aq}) + 4 \text{H}^+(\text{aq}) + 3 \text{e}^-$
Reduction: $3 \text{e}^- + 4 \text{H}^+(\text{aq}) + \text{MnO}_4^-(\text{aq}) \rightarrow \text{MnO}_2(\text{s}) + 2 \text{H}_2\text{O(l)}$
Overall: $2 \text{H}_2\text{O(l)} + \text{Al(s)} + \text{MnO}_4^-(\text{aq}) \rightarrow \text{Al(OH)}_4^-(\text{aq}) + \text{MnO}_2(\text{s})$
- $$\text{NO}_2^-(\text{aq}) + \text{Al(s)} \rightarrow \text{NH}_3(\text{aq}) + \text{AlO}_2^-(\text{aq})$$

Oxidation: $[2 \text{H}_2\text{O(l)} + \text{Al(s)} \rightarrow \text{AlO}_2^-(\text{aq}) + 4 \text{H}^+(\text{aq}) + 3 \text{e}^-] \times 2$
Reduction: $6 \text{e}^- + 7 \text{H}^+(\text{aq}) + \text{NO}_2^-(\text{aq}) \rightarrow \text{NH}_3(\text{aq}) + 2 \text{H}_2\text{O(l)}$
Overall: $\text{OH}^-(\text{aq}) + 2 \text{H}_2\text{O(l)} + 2 \text{Al(s)} + \text{NO}_2^-(\text{aq}) \rightarrow 2 \text{AlO}_2^-(\text{aq}) + \text{NH}_3(\text{aq}) + \text{H}^+(\text{aq}) + \text{OH}^-(\text{aq})$
Overall: $\text{OH}^-(\text{aq}) + \text{H}_2\text{O(l)} + 2 \text{Al(s)} + \text{NO}_2^-(\text{aq}) \rightarrow 2 \text{AlO}_2^-(\text{aq}) + \text{NH}_3(\text{aq})$
- $$\text{Cr(s)} + \text{CrO}_4^{2-}(\text{aq}) \rightarrow \text{Cr(OH)}_3(\text{s})$$

Note: Cr(OH)_3 is found in BOTH half reactions!
Oxidation: $3 \text{H}_2\text{O(l)} + \text{Cr(s)} \rightarrow \text{Cr(OH)}_3(\text{s}) + 3 \text{H}^+(\text{aq}) + 3 \text{e}^-$
Reduction: $3 \text{e}^- + 5 \text{H}^+(\text{aq}) + \text{CrO}_4^{2-}(\text{aq}) \rightarrow \text{Cr(OH)}_3(\text{aq}) + \text{H}_2\text{O(l)}$
Overall: $2 \text{OH}^-(\text{aq}) + 2 \text{H}^+(\text{aq}) + 2 \text{H}_2\text{O(l)} + \text{Cr(s)} + \text{CrO}_4^{2-}(\text{aq}) \rightarrow 2 \text{Cr(OH)}_3(\text{s}) + 2 \text{OH}^-(\text{aq})$
Overall: $4 \text{H}_2\text{O(l)} + \text{Cr(s)} + \text{CrO}_4^{2-}(\text{aq}) \rightarrow 2 \text{Cr(OH)}_3(\text{aq}) + 2 \text{OH}^-(\text{aq})$
- $$\text{MnO}_4^-(\text{aq}) + \text{S}^{2-}(\text{aq}) \rightarrow \text{MnO}_2(\text{s}) + \text{SO}_3^{2-}(\text{aq})$$

Oxidation: $3 \text{H}_2\text{O(l)} + \text{S}^{2-}(\text{aq}) \rightarrow \text{SO}_3^{2-}(\text{aq}) + 6 \text{H}^+(\text{aq}) + 6 \text{e}^-$
Reduction: $[3 \text{e}^- + 4 \text{H}^+(\text{aq}) + \text{MnO}_4^-(\text{aq}) \rightarrow \text{MnO}_2(\text{s}) + 2 \text{H}_2\text{O(l)}] \times 2$
Overall: $2 \text{OH}^-(\text{aq}) + 2 \text{H}^+(\text{aq}) + 2 \text{MnO}_4^-(\text{aq}) + \text{S}^{2-}(\text{aq}) \rightarrow 2 \text{MnO}_2(\text{s}) + \text{SO}_3^{2-}(\text{aq}) + \text{H}_2\text{O(l)} + 2 \text{OH}^-(\text{aq})$
Overall: $\text{H}_2\text{O(l)} + 2 \text{MnO}_4^-(\text{aq}) + \text{S}^{2-}(\text{aq}) \rightarrow 2 \text{MnO}_2(\text{s}) + \text{SO}_3^{2-}(\text{aq}) + 2 \text{OH}^-(\text{aq})$
- $$\text{Cl}_2(\text{aq}) + \text{Br}_2(\text{l}) \rightarrow \text{OBr}^-(\text{aq}) + \text{Cl}^-(\text{aq})$$

Oxidation: $2 \text{H}_2\text{O(l)} + \text{Br}_2(\text{l}) \rightarrow 2 \text{OBr}^-(\text{aq}) + 4 \text{H}^+(\text{aq}) + 2 \text{e}^-$
Reduction: $2 \text{e}^- + \text{Cl}_2(\text{aq}) \rightarrow 2 \text{Cl}^-(\text{aq})$
Overall: $4 \text{OH}^-(\text{aq}) + 2 \text{H}_2\text{O(l)} + \text{Cl}_2(\text{aq}) + \text{Br}_2(\text{l}) \rightarrow 2 \text{OBr}^-(\text{aq}) + 2 \text{Cl}^-(\text{aq}) + 4 \text{H}^+(\text{aq}) + 4 \text{OH}^-(\text{aq})$
Overall: $4 \text{OH}^-(\text{aq}) + \text{Cl}_2(\text{aq}) + \text{Br}_2(\text{l}) \rightarrow 2 \text{OBr}^-(\text{aq}) + 2 \text{Cl}^-(\text{aq}) + 2 \text{H}_2\text{O(l)}$
- $$\text{H}_2\text{O}_2(\text{aq}) + \text{I}^-(\text{aq}) \rightarrow \text{IO}_3^-(\text{aq})$$

Oxidation: $3 \text{H}_2\text{O(l)} + \text{I}^-(\text{aq}) \rightarrow \text{IO}_3^-(\text{aq}) + 6 \text{H}^+(\text{aq}) + 6 \text{e}^-$
Reduction: $[2 \text{e}^- + 2 \text{H}^+(\text{aq}) + \text{H}_2\text{O}_2(\text{aq}) \rightarrow 2 \text{H}_2\text{O(l)}] \times 3$
Overall: $3 \text{H}_2\text{O}_2(\text{aq}) + \text{I}^-(\text{aq}) \rightarrow \text{IO}_3^-(\text{aq}) + 3 \text{H}_2\text{O(l)}$
- $$\text{NO}_3^-(\text{aq}) + \text{NH}_3(\text{aq}) \rightarrow \text{NO}_2^-(\text{aq})$$

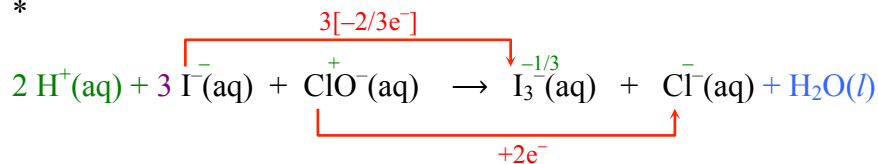
Oxidation: $2 \text{H}_2\text{O(l)} + \text{NH}_3(\text{aq}) \rightarrow \text{NO}_2^-(\text{aq}) + 7 \text{H}^+(\text{aq}) + 6 \text{e}^-$
Reduction: $[2 \text{e}^- + 2 \text{H}^+(\text{aq}) + \text{NO}_3^-(\text{aq}) \rightarrow \text{NO}_2^-(\text{aq}) + \text{H}_2\text{O(l)}] \times 3$
Overall: $\text{OH}^-(\text{aq}) + 3 \text{NO}_3^-(\text{aq}) + \text{NH}_3(\text{aq}) \rightarrow 4 \text{NO}_2^-(\text{aq}) + \text{H}_2\text{O(l)} + \text{H}^+(\text{aq}) + \text{OH}^-(\text{aq})$
Overall: $\text{OH}^-(\text{aq}) + 3 \text{NO}_3^-(\text{aq}) + \text{NH}_3(\text{aq}) \rightarrow 4 \text{NO}_2^-(\text{aq}) + 2 \text{H}_2\text{O(l)}$
- $$\text{S}_8(\text{aq}) + \text{MnO}_4^-(\text{aq}) \rightarrow \text{SO}_4^{2-}(\text{aq}) + \text{MnO}_2(\text{s})$$

Oxidation: $32 \text{H}_2\text{O(l)} + \text{S}_8(\text{aq}) \rightarrow 8 \text{SO}_4^{2-}(\text{aq}) + 64 \text{H}^+(\text{aq}) + 48 \text{e}^-$
Reduction: $[3 \text{e}^- + 4 \text{H}^+(\text{aq}) + \text{MnO}_4^-(\text{aq}) \rightarrow \text{MnO}_2(\text{s}) + 2 \text{H}_2\text{O(l)}] \times 16$
Overall: $\text{S}_8(\text{aq}) + 16 \text{MnO}_4^-(\text{aq}) \rightarrow 8 \text{SO}_4^{2-}(\text{aq}) + 16 \text{MnO}_2(\text{s})$

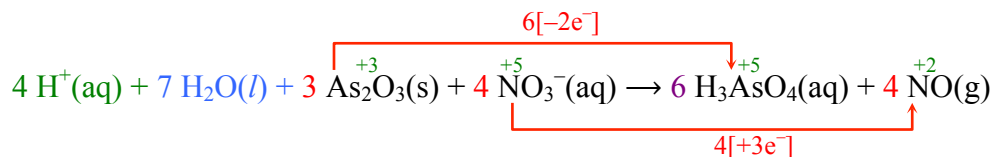
Oxidation Number/Balancing Electrons Method

Redox Reactions in Acidic Solution:

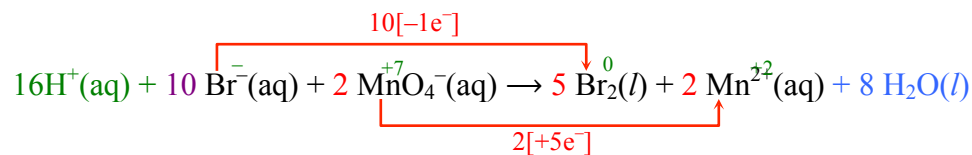
1. *



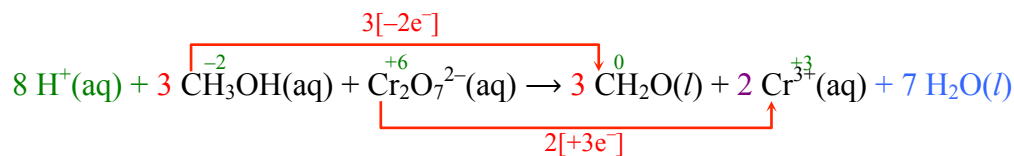
2.



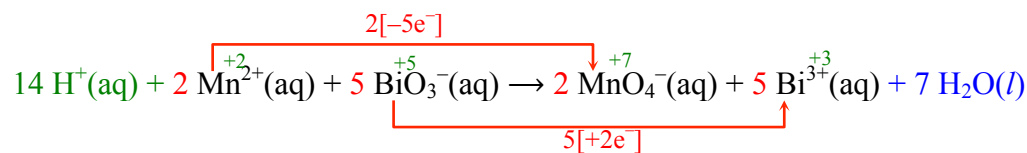
3.



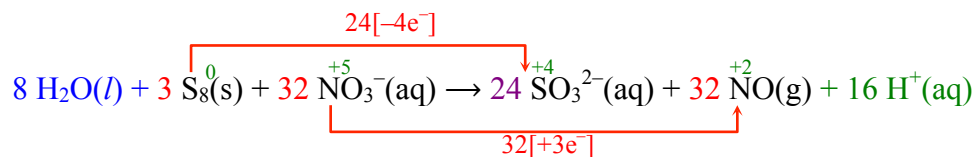
4.



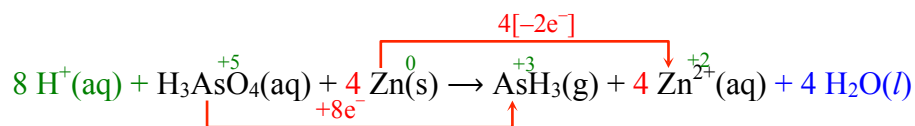
5.



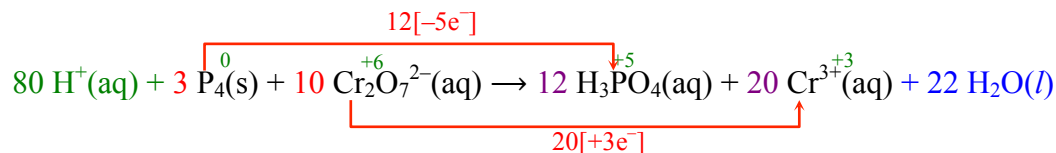
6.



7.



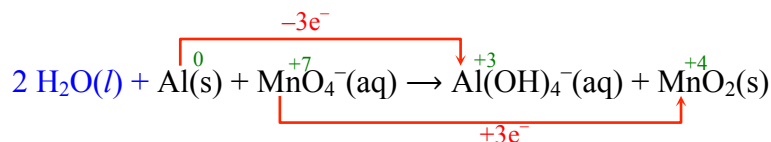
8.



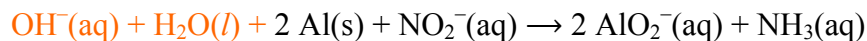
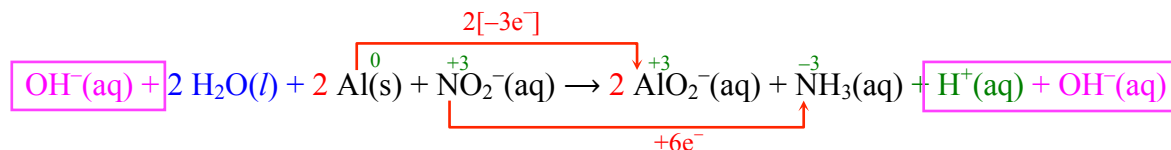
*Difficult to solve using this method

Redox Reactions in Basic Solution

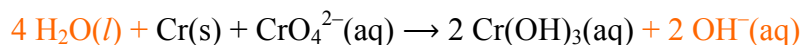
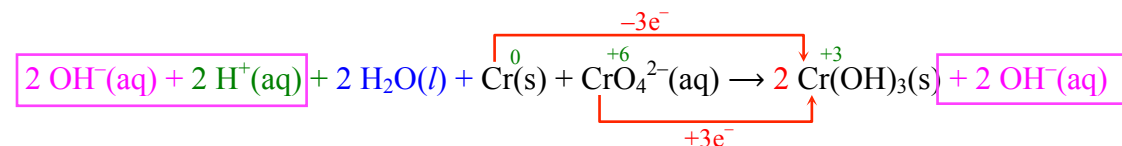
1.



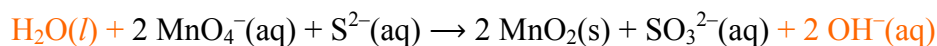
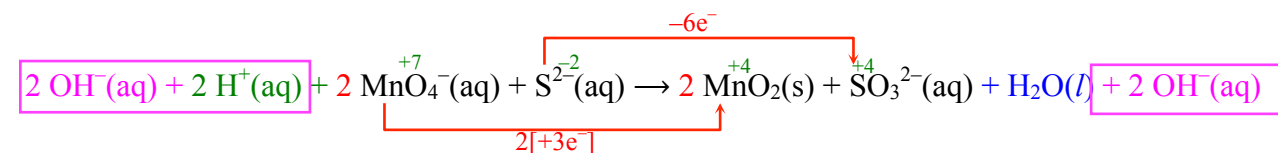
2.



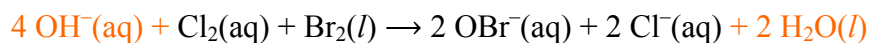
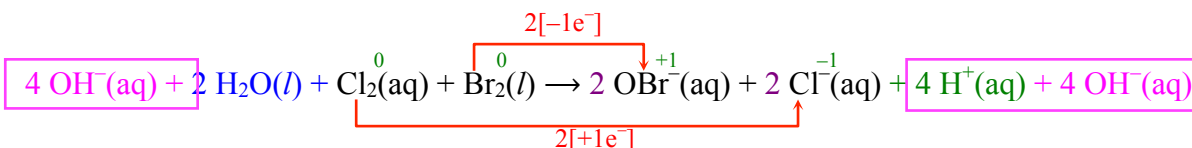
3.



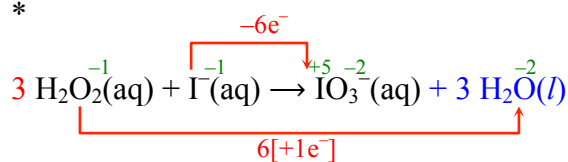
4.



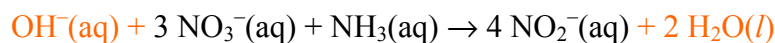
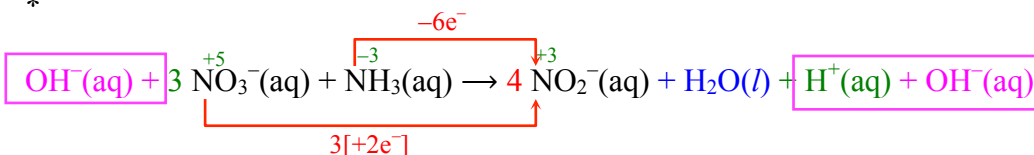
5.



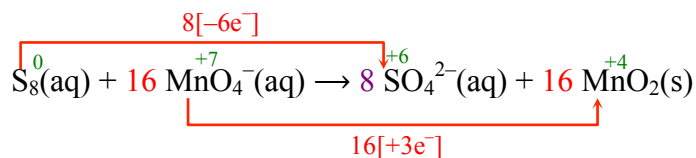
6. *



7. *



8.



*Difficult to solve using this method