

VIII) Balancing Half-Reactions WITHOUT the Use of the Reduction Table

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* Assignment 6: Write a balanced equation for each of the following

- H_2O_2 (acidic) and $\text{N}_2\text{O}_{4(aq)}$
- Ag^+ and $\text{H}_2\text{S}_{(g)}$
- IO_3^- (acidic) and H_2O_2
- H_3PO_4 (acidic) and NO

VIII) Balancing Half-Reactions Without the Use of the Reduction Table

Using the following guidelines, it is possible to build and balance half-reactions that are not on the redox table starting only with a skeleton half-reaction.

Guidelines: 'MAJOR HYDROXIDE' (MAJOR OH⁻)

- MAJOR:** Balance all major elements (all elements except O and H).
- 'O':** Balance oxygen by adding H_2O molecules to the applicable side.
- 'H':** Balance hydrogen by adding H^+ ions to the applicable side.
- :** Balance the charge by adding electrons to the applicable side.
- *5. If necessary: If the half-reaction is basic, you must use the equation $\text{H}_2\text{O} \leftrightarrow \text{H}^+ + \text{OH}^-$ (can also be written the other way around) to cancel protons (which are acidic) from the half-reaction and end up with OH^- ions (which are basic).

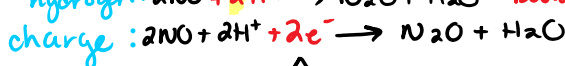
NEVER
change this
order!

"in basic solution"

Practice Questions: (other examples on Hebden p. 201-203):

- Balance the half-reaction whereby NO is reduced to N_2O in acidic solution.

Skeleton half-reaction: $\text{NO} \Rightarrow \text{N}_2\text{O}$



↑
"reduction is gain" of e

Q says:
NO is reduced.
... gain e⁻ to reactants

balance O by adding "H₂O"
balance H by adding "H⁺"

can be H⁺ left over

2) Balance the half-reaction whereby Mn^{2+} is oxidized to MnO_2 in acidic solution

Skeleton half-reaction: $\text{Mn}^{2+} \Rightarrow \text{MnO}_2$

Steps # 1-4

Major: $\text{Mn}^{2+} \rightarrow \text{MnO}_2$ ✓ all ready balanced.

O: $2\text{H}_2\text{O} + \text{Mn}^{2+} \rightarrow \text{MnO}_2 + 2\text{H}_2\text{O}$ to balance 'O'

H: $2\text{H}_2\text{O} + \text{Mn}^{2+} \rightarrow \text{MnO}_2 + 4\text{H}^+$ add H^+ to bal. 'H'

charge: $2\text{H}_2\text{O} + \text{Mn}^{2+} \rightarrow \text{MnO}_2 + 4\text{H}^+ + 2\text{e}^-$

$+2 \rightarrow +4 - 2 = +2$

Q says: "Mn²⁺ is oxidized"
∴ e⁻ being lost (product)

3) Balance the half-reaction whereby HO_2^- is oxidized to O_2 in basic solution.

Skeleton half-reaction: $\text{HO}_2^- \Rightarrow \text{O}_2$

Step # 5 $\text{H}_2\text{O} \rightleftharpoons \text{H}^+ + \text{OH}^-$

① Balance as if it were an acidic solution

Major: ✓ none

O: ✓ all ready bal.

H: $\text{HO}_2^- \rightarrow \text{O}_2 + \text{H}^+$ ← add e⁻ to products.

charge: $\text{HO}_2^- \rightarrow \text{O}_2 + \text{H}^+ + 2\text{e}^-$

② Convert to basic solution - want OH⁻ - cancel H⁺

$\text{H}^+ + \text{OH}^- \rightarrow \text{H}_2\text{O}$

net 1/2 rxn: $\text{HO}_2^- + \text{OH}^- \rightarrow \text{O}_2 + \text{H}_2\text{O} + 2\text{e}^-$

"Acidic"

check:

oxidation - e⁻ as prod. ✓
basic solⁿ - OH⁻ reactant

4) Balance the following half-reaction in basic solution.

Skeleton half-reaction: $\text{Cu}_2\text{O} \Rightarrow \text{Cu}(\text{OH})_2$

Major: $\text{Cu}_2\text{O} \rightarrow 2\text{Cu}(\text{OH})_2$

O: $3\text{H}_2\text{O} + \text{Cu}_2\text{O} \rightarrow 2\text{Cu}(\text{OH})_2$

H: $3\text{H}_2\text{O} + \text{Cu}_2\text{O} \rightarrow 2\text{Cu}(\text{OH})_2 + 2\text{H}^+$

charge: $3\text{H}_2\text{O} + \text{Cu}_2\text{O} \rightarrow 2\text{Cu}(\text{OH})_2 + 2\text{H}^+ + 2\text{e}^-$

Basic Solution

$\text{H}_2\text{O} \rightleftharpoons \text{H}^+ + \text{OH}^-$

$2\text{H}^+ + 2\text{OH}^- \rightarrow 2\text{H}_2\text{O}$

Net 1/2 reaction: $\text{H}_2\text{O} + \text{Cu}_2\text{O} + 2\text{OH}^- \rightarrow 2\text{Cu}(\text{OH})_2 + 2\text{e}^-$

Acidic.

Assignment 7:

1) Do Hebden p. 203 #19a-m