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

April 30, 2018 8:32 PM

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

a) H_2O_2 (acidic) and $N_2O_{4(aq)}$

b) Ag^+ and $H_2S_{(g)}$

c) IO_3^- (acidic) and H_2O_2

d) 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^-)**

1. MAJOR: Balance all major elements (all elements except O and H).
2. 'O': Balance oxygen by adding H_2O molecules to the applicable side.
3. 'H': Balance hydrogen by adding H^+ ions to the applicable side.
4. -: Balance the charge by adding electrons to the applicable side.
5. *5. If necessary: If the half-reaction is basic, you must use the equation $H_2O \Leftrightarrow H^+ + OH^-$ *(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):*

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

Skeleton half-reaction: $NO \Rightarrow N_2O$

major: $2NO \rightarrow N_2O$

oxygen: $2NO \rightarrow N_2O + H_2O$ balance O by adding "H_2O"

hydrogen: $2NO + 2H^+ \rightarrow N_2O + H_2O$ balance H by adding "H^+"

charge: $2NO + 2H^+ + 2e^- \rightarrow N_2O + H_2O$

"reduction is gain of e^-"

Q says: NO is reduced ... gain e^- ... e^- to reactants

can be H^+ left over

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

Skeleton half-reaction: $Mn^{2+} \Rightarrow MnO_2$

Steps #1–4

Major: $Mn^{2+} \rightarrow MnO_2$ ✓ already balanced.

O: $2H_2O + Mn^{2+} \rightarrow MnO_2$ + $2H_2O$ to balance 'O'

H: $2H_2O + Mn^{2+} \rightarrow MnO_2 + 4H^+$ add H^+ to bal. 'H'

charge: $2H_2O + Mn^{2+} \rightarrow MnO_2 + 4H^+ + 2e^-$

+2 → +4 −2 = +2

Q says: "Mn^{2+} 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: $HO_2^- \Rightarrow O_2$

Step #5 $H_2O \rightleftharpoons H^+ + OH^-$

(1) Balance as if it were an acidic solution

Major: ✓ none

O: ✓ already bal.

H: $HO_2^- \rightarrow O_2 + H^+$ add e^- to products.

−: $HO_2^- \rightarrow O_2 + H^+ + 2e^-$ "Acidic"

(2) Convert to basic solution – cancel H^+ – want OH^-

$H^+ + OH^- \rightarrow H_2O$

net ½ rxn: $HO_2^- + OH^- \rightarrow O_2 + H_2O + 2e^-$

Check: oxidation – e^- as prod. ✓ basic sol'n – OH^- reactant ✓

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

Skeleton half-reaction: $Cu_2O \Rightarrow Cu(OH)_2$

Major: $Cu_2O \rightarrow 2Cu(OH)_2$

O: $3H_2O + Cu_2O \rightarrow 2Cu(OH)_2$

H: $3H_2O + Cu_2O \rightarrow 2Cu(OH)_2 + 2H^+$

charge: $3H_2O + Cu_2O \rightarrow 2Cu(OH)_2 + 2H^+ + 2e^-$ Acidic.

Basic Solution: $2H^+ + 2OH^- \rightarrow 2H_2O$

$H_2O \rightleftharpoons H^+ + OH^-$

Net ½ reaction: $H_2O + Cu_2O + 2OH^- \rightarrow 2Cu(OH)_2 + 2e^-$

Assignment 7:

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