Chemistry 12

Electrochemistry II

Name:
Date:
Block:

1. **Half-Reactions**
2. **Balancing Redox Reactions**

Half-Reactions

Consider the following reaction:

$$Zn_{(s)} + 2\ Cu^{+}_{(aq)} \rightarrow Zn^{2+}_{(aq)} + 2\ Cu_{(s)}$$

- Notice that 2 Cu^{+} ions are reduced for every 1 Zn atom oxidized.
- It is possible to separate out the reduction and oxidation portions of a redox reaction.
- **Half-reactions: an equation representing either an oxidation or a reduction including the number of electrons lost or gained.**

Oxidation: $Zn \rightarrow Zn^{2+} + 2\ e^{-}$
Reduction: $Cu^{+} + e^{-} \rightarrow Cu$

Consider the following reaction:

$$IO_3^{-} + HSO_3^{-} \rightarrow SO_4^{2-} + I_2$$

Oxidation: Reduction:

Balancing Half-Reactions Steps:

1.
2.
3.
4.
5.

- Most reactions occur in acidic conditions. However, if it is stated that the reaction takes place in basic conditions…

6.

Practice:

Balance the following half-reactions. Also state whether this is an oxidation or a reduction:

1. $ClO_4^- \rightarrow Cl_2$

□ Balance major atoms. □ Balance O's. □ Balance H's. □ Balance charge. (check!)

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2. $Sm \rightarrow Sm^{3+}$

□ Balance major atoms. □ Balance O's. □ Balance H's. □ Balance charge. (check!)

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3. $NO_3^- \rightarrow NH_4^+$

□ Balance major atoms. □ Balance O's. □ Balance H's. □ Balance charge. (check!)

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4. $S_2O_3^{2-} \rightarrow SO_4^{2-}$
(basic)

□ Balance major atoms. □ Balance O's. □ Balance H's. □ Balance charge. (check!)

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Balancing Redox Reactions:

Rules:

1.

2.

3.

4.

5.

Practice:

$$IO_3^- + HSO_3^- \rightarrow SO_4^{2-} + I_2$$

- Separate into two half reactions. (Look for common atoms to help you.)

- Balance each half reaction. (There must be an electron gain in one side and loss on the other!)

- Balance the electron loss and gain. (check oxidation numbers!)

- Add the balanced half-reactions together, cancelling where appropriate.

$H_3AsO_4 + Zn \rightarrow AsH_3 + Zn^{2+}$

$FeHPO_3 + Cr_2O_7^{2-} \rightarrow Cr^{3+} + H_3PO_4 + Fe^{3+}$
(under basic conditions)

A disproportionation reaction is a redox reaction in which the same species is both reduced and oxidized. Since there is only one reactant, the reactant must be involved in both the reduction reaction and the oxidation reaction.

$$ClO_2^- \rightarrow ClO_3^- + Cl^-$$

$$P_4 \rightarrow HPO_4^{2-} + PH_3$$

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Worksheet

EXERCISE:

19. Balance the following half–reactions.

a) $Ce^{4+} \rightleftharpoons Ce^{2+}$

b) $I_2 \rightleftharpoons I^-$

c) $Mn^{2+} \rightleftharpoons MnO_2$ (acidic solution)

d) $O_2 \rightleftharpoons H_2O_2$ (acidic solution)

e) $S_2O_8^{2-} \rightleftharpoons HSO_4^-$ (acidic solution)

f) $H_3AsO_4 \rightleftharpoons HAsO_2$ (acidic solution)

g) $H_2SeO_3 \rightleftharpoons Se$ (acidic solution)

h) $N_2H_4 \rightleftharpoons N_2$ (basic solution)

i) $HO_2^- \rightleftharpoons O_2$ (basic solution)

j) $HXeO_4^- \rightleftharpoons HXeO_6^{3-}$ (basic solution)

k) $HC_2H_3O_2 \rightleftharpoons C_2H_5OH$ (acidic solution)

l) $Cr(OH)_3 \rightleftharpoons CrO_4^{2-}$ (basic solution)

m) $CH_3CHO \rightleftharpoons CH_2CH_2$ (acidic solution)

EXERCISE:

24. Balance the following redox equations.

a) $U^{4+} + MnO_4^- \longrightarrow Mn^{2+} + UO_2^{2+}$ (acidic)

b) $Zn + As_2O_3 \longrightarrow AsH_3 + Zn^{2+}$ (acidic)

c) $Fe^{2+} + Cr_2O_7^{2-} \longrightarrow Cr^{3+} + Fe^{3+}$ (acidic)

d) $Cl_2 + SO_2 \longrightarrow Cl^- + SO_4^{2-}$ (acidic)

e) $Cu + NO_3^- \longrightarrow Cu^{2+} + NO$ (acidic)

f) $S^{2-} + ClO_3^- \longrightarrow Cl^- + S$ (basic)

g) $OCl^- \longrightarrow Cl^- + ClO_3^-$ (basic)

h) $CN^- + IO_3^- \longrightarrow I^- + CNO^-$ (basic)

i) $Sn^{2+} + H_2O_2 \longrightarrow Sn^{4+}$ (basic)

j) $Br_2 \longrightarrow Br^- + BrO_3^-$ (basic)

k) $HSO_3^- + IO_3^- \longrightarrow I_2 + SO_4^{2-}$ (acidic)

l) $HNO_2 \longrightarrow HNO_3 + NO$

m) $Mn^{2+} + HBiO_3 \longrightarrow Bi^{3+} + MnO_4^-$ (acidic)

n) $H_2O_2 + Cr(OH)_4^- \longrightarrow CrO_4^{2-}$ (basic)

o) $Sb_2S_3 + NO_3^- \longrightarrow NO_2 + SO_4^{2-} + Sb_2O_5$ (acidic)

p) $As_2S_3 + NO_3^- \longrightarrow NO + SO_4^{2-} + H_3AsO_4$ (acidic)

q) $FeS + NO_3^- \longrightarrow NO + SO_4^{2-} + Fe^{3+}$ (acidic)

r) $FeHPO_3 + Cr_2O_7^{2-} \longrightarrow Cr^{3+} + H_3PO_4 + Fe^{3+}$ (acidic)

s) $SnS_2O_3 + MnO_4^- \longrightarrow Mn^{2+} + SO_4^{2-} + Sn^{4+}$ (acidic)

t) $CuS + HNO_3 \longrightarrow Cu(NO_3)_2 + NO_2 + SO_2$

u) $Ca_3(PO_4)_2 + SiO_2 + C \longrightarrow P_4 + CaSiO_3 + CO$

v) $KMnO_4 + H_2S + H_2SO_4 \longrightarrow K_2SO_4 + MnSO_4 + S$

w) $CuF_2 + NH_3 \longrightarrow Cu_3N + NH_4F + N_2$
