Chemistry 102

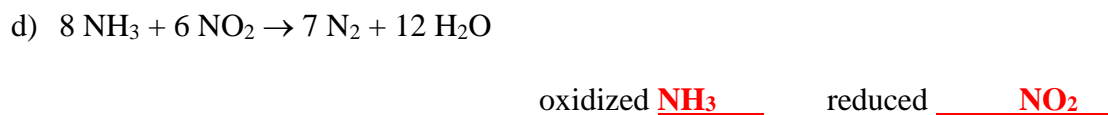## REDOX REACTONS
Chapters 4 & 20

1. In the compounds below, assign oxidation numbers to each element:

    a) $H_3\underline{P}O_2$ P : **+1**   d) $H_2\underline{C}O$ C : **0**
    b) $Na_2\underline{C}_2O_4$ C : **+3**   e) $\underline{Cl}F_4{}^-$ Cl : **+3**

    c) $Mn\underline{S}O_4$ S : **+6**   g) $Al\underline{H}_3$ H : **−1**

2. Identify which substance is oxidized and which substance is reduced in each of the following redox reactions.

    a) $2\ Al + 3\ Cl_2 \rightarrow 2\ AlCl_3$ oxidized **Al**   reduced **Cl₂**

    b) $2\ NiS + 3\ O_2 \rightarrow 2\ NiO + 2\ SO_2$ oxidized **S²⁻**   reduced **O₂**

    c) $3\ H_2S + 2\ HNO_3 \rightarrow 3\ S + 2\ NO + 4\ H_2O$

                      oxidized **S²⁻**   reduced **HNO₃**

    d) $8\ NH_3 + 6\ NO_2 \rightarrow 7\ N_2 + 12\ H_2O$

                      oxidized **NH₃**   reduced **NO₂**
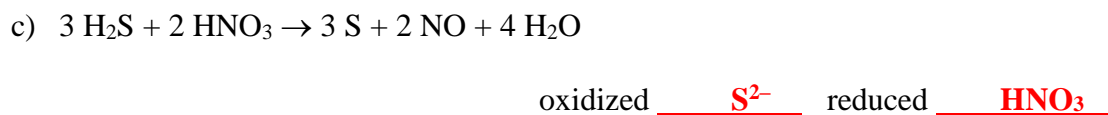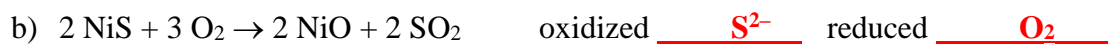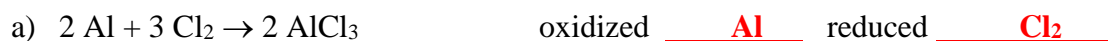
BALANCING REDOX REACTIONS
Half-Reaction Method

1. Assign oxidation number to each element and identify the substance being oxidized and the substance being reduced.
2. Write oxidation and reduction half-reactions. In oxidation half-reaction electrons should appear on the product side, and in the reduction half-reaction they should appear on the reactant side.
3. Balance each half-reaction with respect to all elements, except H and O.

For Acid Solutions:

4. Add the appropriate number of H_2O molecules to the deficient side to balance O.
5. Add H^+ to the deficient side to balance H.

For Basic Solutions:

4. For each deficient O:
   Add two (2) hydroxides, OH^-, to the deficient side.
   Add one (1) water, H_2O, to the other side.

5. For each deficient H:
   Add one (1) water, H_2O, to the deficient side.
   Add one (1) hydroxide, OH^-, to the other side.

Balance each of the following redox reactions using the half-reaction method:

1. $Cu + HNO_3 \rightarrow Cu^{2+} + NO$ (acidic solution)

Oxidation _____Cu__ ___2____ element # of e⁻	HALF-REACTION **3 x [Cu → Cu²⁺ + 2 e⁻]** **3 Cu → 3 Cu²⁺ + 6 e⁻**
Reduction _____N____ ___3____ element # of e⁻	HALF-REACTION **HNO₃ + 3 e⁻ → NO** **2 x [3 H⁺ + HNO₃ + 3 e⁻ → NO + 2 H₂O]** **6 H⁺+ 2 HNO₃ + 6 e⁻→ 2 NO + 4 H₂O**
Balanced total reaction	**6 H⁺+3 Cu + 2 HNO₃→ 3 Cu²⁺ + 2 NO + 4 H₂O**

2. $Bi(OH)_3 + SnO_2^{2-} \rightarrow SnO_3^{2-} + Bi$ (basic solution)

	HALF-REACTION
Oxidation _____Sn___ ___2____ element # of e$^-$	$SnO_2^{2-} \rightarrow SnO_3^{2-} + 2\ e^-$ $3 \times [2\ OH^- + SnO_2^{2-} \rightarrow SnO_3^{2-} + 2\ e^- + H_2O]$ $6\ OH^- + 3\ SnO_2^{2-} \rightarrow 3\ SnO_3^{2-} + 6\ e^- + 3\ H_2O$
Reduction ____Bi_____ ___3____ element # of e$^-$	HALF-REACTION $Bi(OH)_3 + 3\ e^- \rightarrow Bi$ $2 \times [Bi(OH)_3 + 3\ e^- \rightarrow Bi + 3\ OH^-]$ $2\ Bi(OH)_3 + 6\ e^- \rightarrow 2\ Bi + 6\ OH^-$
Balanced total reaction	$2\ Bi(OH)_3 + 3\ SnO_2^{2-} \rightarrow 2\ Bi + 3\ SnO_3^{2-} + 3\ H_2O$

3. $S_2O_3^{2-} + I_2 \rightarrow S_4O_6^{2-} + I^-$ (acidic solution)
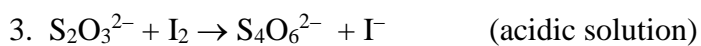
	HALF-REACTION
Oxidation ____S_____ ___0.5___ element # of e$^-$	$2\ S_2O_3^{2-} \rightarrow S_4O_6^{2-} + 2\ e^-$
Reduction ____I_____ ____1_____ element # of e$^-$	HALF-REACTION $I_2 + 2\ e^- \rightarrow 2\ I^-$
Balanced total reaction	$2\ S_2O_3^{2-} + I_2 \rightarrow S_4O_6^{2-} + 2\ I^-$

4. $MnO_4^- + I^- \rightarrow MnO_4^{2-} + IO_3^-$ (basic solution)

	HALF-REACTION
Oxidation ____I____ ____6____ element # of e⁻	$I^- \rightarrow IO_3^- + 6\ e^-$ $6\ OH^- + I^- \rightarrow IO_3^- + 6\ e^- + 3\ H_2O$
	HALF-REACTION
Reduction ____Mn____ ____1____ element # of e⁻	$MnO_4^- + 1\ e^- \rightarrow MnO_4^{2-}$ $6\ x\ [MnO_4^- + 1\ e^- \rightarrow MnO_4^{2-}]$ $6\ MnO_4^- + 6\ e^- \rightarrow 6\ MnO_4^{2-}$
Balanced total reaction	$6\ OH^- + 6\ MnO_4^- + I^- \rightarrow 6\ MnO_4^{2-} + IO_3^- + 3\ H_2O$

5. $Br_2 \rightarrow BrO_3^- + Br^-$ (basic solution)

	HALF-REACTION
Oxidation ____Br____ ____5____ element # of e⁻	$Br_2 \rightarrow 2\ BrO_3^- + 10\ e^-$ $12\ OH^- + Br_2 \rightarrow 2\ BrO_3^- + 10\ e^-\ 6\ H_2O$
	HALF-REACTION
Reduction ____Br____ ____1____ element # of e⁻	$5\ x\ [Br_2 + 2\ e^- \rightarrow 2\ Br^-]$ $5\ Br_2 + 10\ e^- \rightarrow 10\ Br^-$
Balanced total reaction	$12\ OH^- + 6\ Br_2 \rightarrow 2\ BrO_3^- + 10\ Br^- + 6\ H_2O$ $6\ OH^- + 3\ Br_2 \rightarrow BrO_3^- + 5\ Br^- + 3\ H_2O$