Chemistry 102

ANSWER KEY

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 **Cl_2**

b) $2\ NiS + 3\ O_2 \rightarrow 2\ NiO + 2\ SO_2$ oxidized **S^{2-}** reduced **O_2**

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

oxidized **S^{2-}** reduced **HNO_3**

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

oxidized **NH_3** reduced **NO_2**

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 → Cu^{2+} + 2 e^-]** **3 Cu → 3 Cu^{2+} + 6 e^-**
Reduction **_____N____ ___3____** element # of e^-	HALF-REACTION **HNO_3 + 3 e^- → NO** **2 x [3 H^+ + HNO_3 + 3 e^- → NO + 2 H_2O]** **6 H^++ 2 HNO_3 + 6 e^-→ 2 NO + 4 H_2O**
Balanced total reaction	**6 H^++3 Cu + 2 HNO_3→ 3 Cu^{2+} + 2 NO + 4 H_2O**

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

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

Oxidation **____S_____** **___0.5___** element # of e^-	HALF-REACTION **$2\ S_2O_3^{2-} \rightarrow S_4O_6^{2-} + 2\ e^-$**
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)

Oxidation **____I____** **____6____** element # of e^-	HALF-REACTION **$I^- \rightarrow IO_3^- + 6\ e^-$** **$6\ OH^- + I^- \rightarrow IO_3^- + 6\ e^- + 3\ H_2O$**
Reduction **____Mn___** **___1____** element # of e^-	HALF-REACTION **$MnO_4^- + 1\ e^- \rightarrow MnO_4^{2-}$** **$6 \times [MnO_4^- + 1\ e^- \rightarrow MnO_4^{2-}]$** **$6\ MnO_4^- + 6\ e^- \rightarrow 6\ MnO_4^{2-}$**
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)

Oxidation **____Br____** **___5____** element # of e^-	HALF-REACTION **$Br_2 \rightarrow 2\ BrO_3^- + 10\ e^-$** **$12\ OH^- + Br_2 \rightarrow 2\ BrO_3^- + 10\ e^-\ 6\ H_2O$**
Reduction **____Br____** **___1____** element # of e^-	HALF-REACTION **$5 \times [Br_2 + 2\ e^- \rightarrow 2\ Br^-]$** **$5\ Br_2 + 10\ e^- \rightarrow 10\ Br^-$**
Balanced total reaction	**$12\ OH^- + 6\ Br_2 \rightarrow 2\ BrO_3^- + 10\ Br^- + 6\ H_2O$** **$6\ OH^- + 3\ Br_2 \rightarrow BrO_3^- + 5\ Br^- + 3\ H_2O$**