Chemistry 30

Unit 6: Redox Reactions and Electrochemistry

Practice Set 3: Balancing Redox Reactions

1. Balance the following redox reactions using the oxidation number method.

   a. $SnCl_2 + HgCl_2 \rightarrow SnCl_4 + HgCl$

	initial		final	change		Coefficient		Total e^-
Sn	+2	$\rightarrow$	+4	2	$\times$	**1**	=	2
Hg	+2	$\rightarrow$	+1	1	$\times$	**2**	=	2

   Place a "1" in front of compounds containing Sn, and a "2" in front of compounds with Hg:

   Answer: $\mathbf{1}\ SnCl_2 + \mathbf{2}\ HgCl_2 \rightarrow \mathbf{1}\ SnCl_4 + \mathbf{2}\ HgCl$

   Double check to make sure all other atoms in the equation are balanced.

   b. $HNO_3 + H_2S \rightarrow NO + S + H_2O$

	initial		final	change		Coefficient		Total e^-
N	+5	$\rightarrow$	+2	3	$\times$	**2**	=	6
S	-2	$\rightarrow$	0	2	$\times$	**3**	=	6

   Place a "2" in front of compounds containing N, and a "3" in front of compounds with S. Then balance for hydrogen and oxygen.

   Answer: $\mathbf{2}\ HNO_3 + \mathbf{3}\ H_2S \rightarrow \mathbf{2}\ NO + \mathbf{3}\ S + \mathbf{4}\ H_2O$

   c. $NaClO + H_2S \rightarrow NaCl + H_2SO_4$

	initial		final	change		Coefficient		Total e^-
Cl	+1	$\rightarrow$	-1	2	$\times$	**4**	=	8
S	-2	$\rightarrow$	+6	8	$\times$	**1**	=	8

   Answer: $\mathbf{4}\ NaClO + \mathbf{1}\ H_2S \rightarrow \mathbf{4}\ NaCl + \mathbf{1}\ H_2SO_4$

d. $CdS + I_2 + HCl \rightarrow CdCl_2 + HI + S$

Because one of the atoms undergoing oxidation or reduction has a subscript (I_2) we will account for the number of atoms of each element when preparing our summary chart:

	initial		final	change		no. atoms		No. e^-		Coefficient		Total e^-
S	-2	→	0	2				2	×	**1**	=	2
I	0	→	-1	1	×	2 (in I_2)	=	2	×	**1**	=	2

Place the balancing coefficients into the equation in front of the elements undergoing oxidation and reduction. For iodine, the 1 will go in front of the diatomic I_2 because these were the atoms being counted.

$\mathbf{1}\ CdS + \mathbf{1}\ I_2 + HCl \rightarrow CdCl_2 + HI + \mathbf{1}\ S$

Then balance the rest of the equation. First balance for iodine atoms, then for Cd and H:

Answer: $\mathbf{1}\ CdS + \mathbf{1}\ I_2 + \mathbf{2}\ HCl \rightarrow \mathbf{1}\ CdCl_2 + \mathbf{2}\ HI + \mathbf{1}\ S$

e. $I_2 + HNO_3 \rightarrow HIO_3 + NO_2 + H_2O$

	initial		final	change		no. atoms		No. e^-		Coefficient		Total e^-
I	0	→	+5	5	×	2 (in I_2)		10	×	**1**	=	10
N	+5	→	+4	1			=	1	×	**10**	=	10

Because of the subscript with iodine (I_2), we multiply the change in oxidation number for iodine by 2 before we determine our coefficient multipliers.

The "1" for iodine is placed in front of the diatomic iodine; the "10" goes in front of both nitrogens. Then balance for iodine on both sides of the equation, then for all other atoms.

Answer: $\mathbf{1}\ I_2 + \mathbf{10}\ HNO_3 \rightarrow \mathbf{2}\ HIO_3 + \mathbf{10}\ NO_2 + \mathbf{4}\ H_2O$

f. $MnO_4^- + H^+ + Cl^- \rightarrow Mn^{2+} + Cl_2 + H_2O$

	initial		final	change		no. atoms		No. e^-		Coefficient		Total e^-
Mn	+7	→	+2	5				5	×	**2**	=	10
Cl	-1	→	0	1	×	2 (in Cl_2)	=	2	×	**5**	=	10

Because of the diatomic chlorine (Cl_2) we multiply the change in oxidation number for chlorine by 2. We then determine what coefficients are needed to balance for electrons. The "5" for chlorine will be placed in front of the diatomic chlorine. Then balance both sides of the equation for chlorine, then for all other atoms.

Answer: $\mathbf{2}\ MnO_4^- + \mathbf{16}\ H^+ + \mathbf{10}\ Cl^- \rightarrow \mathbf{2}\ Mn^{2+} + \mathbf{5}\ Cl_2 + \mathbf{8}\ H_2O$

2. Balance the following half-reactions for both atoms and electrons by adding the appropriate number of electrons to the correct side of the equation. Also identify each as either an oxidation or reduction.

a. $Pb^{2+} \rightarrow Pb$ **$Pb^{2+} + 2e^- \rightarrow Pb$** **reduction**

b. $Cl_2 \rightarrow Cl^-$ **$Cl_2 + 2\ e^- \rightarrow 2\ Cl^-$** **reduction**

c. $Fe^{3+} \rightarrow Fe^{2+}$ **$Fe^{3+} + e^- \rightarrow Fe^{2+}$** **reduction**

d. $N_2O + H_2O \rightarrow NO + H^+$ **$N_2O + H_2O \rightarrow 2\ NO + 2\ H^+ + 2e^-$** **oxidation**

3. Break each equation into two half-reactions. Identify each half-reaction as oxidation or reduction.

a. $Cu + 2\ H^+ \rightarrow Cu^{2+} + H_2$

$Cu \rightarrow Cu^{2+} + 2\ e^-$ **oxidation**

$2\ H^+ + 2\ e^- \rightarrow H_2$ **reduction**

b. $2\ Al + 3\ S \rightarrow Al_2S_3$

$2\ Al \rightarrow 2Al^{+3} + 6\ e^-$ **oxidation**

$3S + 6e^- \rightarrow 3\ S^{2-}$ **reduction**

4. Balance the following equations using the half-reaction method.

a. $Na + Br_2 \rightarrow NaBr$

Step 1	**Step 2**	**Step 3**
Write the two balanced half-reactions, removing any spectator ions:	**Balance for electrons**	**Add the half-reactions, replacing any spectator ions that were removed and/or recombining compounds**
$Na \rightarrow Na^+ + e^-$	multiply by 2	$2\ Na \rightarrow 2\ Na^+ + 2e^-$
$Br_2 + 2\ e^- \rightarrow 2\ Br^-$		$Br_2 + 2\ e^- \rightarrow 2\ Br^-$
	added together:	$2\ Na + Br_2 \rightarrow 2\ Na^+ + 2\ Br^-$
	reform compound:	$2\ Na + Br_2 \rightarrow 2\ NaBr$

b. $Zn + S \rightarrow ZnS$

Step 1	Step 2	Step 3
Write the two balanced half-reactions, removing any spectator ions:	**Balance for electrons**	**Add the half-reactions, replacing any spectator ions that were removed and/or recombining compounds**
$Zn \rightarrow Zn^{2+} + 2\ e^-$		$Zn \rightarrow Zn^{2+} + 2\ e^-$
$S + 2\ e^- \rightarrow S^{2-}$		$S + 2\ e^- \rightarrow S^{2-}$
	added together:	$Zn + S \rightarrow Zn^{2+} + S^{2-}$
	reform compound:	$Zn + S \rightarrow ZnS$

c. $Ag + Cr_2O_7^{2-} + H^+ \rightarrow Ag^+ + Cr^{3+} + H_2O$

For each half-reaction, remember to balance for atoms first, then add electrons to balance for charge.

Step 1	Step 2	Step 3
Write the two balanced half-reactions, removing any spectator ions:	**Balance electrons**	**Add the half-reactions, replacing any spectator ions that were removed and/or recombining compounds**
$Ag \rightarrow Ag^+ + e^-$	$\times 6$	$6\ Ag \rightarrow 6\ Ag^+ + 6\ e^-$
$Cr_2O_7^{2-} + 14\ H^+ + 6\ e^- \rightarrow 2\ Cr^{3+} + 7\ H_2O$		$Cr_2O_7^{2-} + 14\ H^+ + 6\ e^- \rightarrow 2\ Cr^{3+} + 7\ H_2O$
added together:		$6Ag + Cr_2O_7^{2-} + 14H^+ \rightarrow 6Ag^+ + 2Cr^{3+} + 7H_2O$