Half Reaction Practice - KEY

Equation #1: $Zn + Fe^{3+} \rightarrow Zn^{2+} + Fe$

1. *Zinc goes from 0 to +2 and iron goes from +3 to 0. The changes in oxidation state indicate a redox reaction occurred.*

2. *Zinc is losing electrons, while iron is gaining electrons.*

3. *Zinc is oxidized because the oxidation number increases, meaning electrons are lost. Iron is reduced because the oxidation number decreases, meaning electrons are gained.*

4. *Zn^0 is the reducing agent (because it is oxidized) and Fe^{3+} is the oxidizing agent (because it is reduced).*

5. *Half reactions:*
   a. *Oxidation: $Zn^0 \rightarrow Zn^{2+} + 2\ e^-$ BALANCE $3(Zn^0 \rightarrow Zn^{2+} + 2\ e^-) = 3\ Zn^0 \rightarrow 3\ Zn^{2+} + 6\ e^-$*
   b. *Reduction: $Fe^{3+} + 3\ e^- \rightarrow Fe^0$ BALANCE $2(Fe^{3+} + 3e^- \rightarrow Fe^0) = 2\ Fe^{3+} + 6\ e^- \rightarrow 2\ Fe^0$*

6. $3\ Zn + 2\ Fe^{3+} \rightarrow 3\ Zn^{2+} + 2\ Fe$

7. *The above balanced equation shows conservation of mass because there are 2 moles of iron on each sides of the equation, and 3 moles of zinc on each side of the equation. It shows conservation of charge because the sum of the charges on the left side is (+6), and the sum of the charges on the right side is (+6). Both sides of the equation have the same net charge. In addition, from the balanced half-reactions, we see the electrons lost by Zn^0 is equal to the electrons gained by Fe^{3+}.*

Equation #2: $Al + Ni^{2+} \rightarrow Al^{3+}\ Ni$

1. *Aluminum goes from 0 to +3 and nickel goes from +2 to 0. The changes in oxidation state indicate a redox reaction occurred.*

2. *Aluminum is losing electrons, while nickel is gaining electrons.*

3. *Aluminum is oxidized because the oxidation number increases, meaning electrons are lost. Nickel is reduced because the oxidation number decreases, meaning electrons are gained.*

4. *Al^0 is the reducing agent (because it is oxidized) and Ni^{2+} is the oxidizing agent (because it is reduced).*

5. *Half reactions:*
   a. *Oxidation: $Al^0 \rightarrow Al^{3+} + 3\ e^-$ BALANCE $2(Al^0 \rightarrow Al^{3+} + 3\ e^-) = 2\ Al^0 \rightarrow 2\ Al^{3+} + 6\ e^-$*
   b. *Reduction: $Ni^{2+} + 2\ e^- \rightarrow Ni^0$ BALANCE $3(Ni^{2+} + 2\ e^- \rightarrow Ni^0) = 3\ Ni^{2+} + 6\ e^- \rightarrow 3\ Ni^0$*

6. $2\ Al + 3\ Ni^{2+} \rightarrow 2\ Al^{3+} + 3\ Ni$

7. *The above balanced equation shows conservation of mass because there are 2 moles of aluminum on each sides of the equation, and 3 moles of nickel on each side of the equation. It shows conservation of charge because the sum of the charges on the left side is (+6), and the sum of the charges on the right side is (+6). Both sides of the equation have the same net charge. In addition, from the balanced half-reactions, we see the electrons lost by Al^0 is equal to the electrons gained by Ni^{2+}.*

Equation #3: $Cu + Ag^{+} \rightarrow Cu^{2+} + Ag$

1. *Copper goes from 0 to +2 and silver goes from +1 to 0. The changes in oxidation state indicate a redox reaction occurred.*

2. *Copper is losing electrons, while silver is gaining electrons.*

3. *Coper is oxidized because the oxidation number increases, meaning electrons are lost. Silver is reduced because the oxidation number decreases, meaning electrons are gained.*

4. *Cu^0 is the reducing agent (because it is oxidized) and Ag^+ is the oxidizing agent (because it is reduced).*

5. *Half reactions:*
    a. *Oxidation: $Cu^0 \rightarrow Cu^{2+} + 2\ e^-$ BALANCE no balancing needed = $Cu^0 \rightarrow Cu^{2+} + 2\ e^-$*
    b. *Reduction: $Ag^+ + e^- \rightarrow Ag^0$ BALANCE $2(Ag^+ + e^- \rightarrow Ag^0) = 2\ Ag^+ + 2\ e^- \rightarrow 2\ Ag^0$*

6. $Cu + 2\ Ag^+ \rightarrow Cu^{2+} + 2\ Ag$

7. *The above balanced equation shows conservation of mass because there are 2 moles of silver on each sides of the equation, and 1 mole of copper on each side of the equation. It shows conservation of charge because the sum of the charges on the left side is (+2), and the sum of the charges on the right side is (+2). Both sides of the equation have the same net charge. In addition, from the balanced half-reactions, we see the electrons lost by Cu^0 is equal to the electrons gained by Ag^+.*

Equation #4: $Ag^{+} + Pb \rightarrow Pb^{2+} + Ag$

1. *Lead goes from 0 to +2 and silver goes from +1 to 0. The changes in oxidation state indicate a redox reaction occurred.*

2. *Lead is losing electrons, while silver is gaining electrons.*

3. *Lead is oxidized because the oxidation number increases, meaning electrons are lost. Silver is reduced because the oxidation number decreases, meaning electrons are gained.*

4. *Pb^0 is the reducing agent (because it is oxidized) and Ag^+ is the oxidizing agent (because it is reduced).*

5. *Half reactions:*
    a. *Oxidation: $Pb^0 \rightarrow Pb^{2+} + 2\ e^-$ BALANCE no balancing needed = $Pb^0 \rightarrow Pb^{2+} + 2\ e^-$*
    b. *Reduction: $Ag^+ + e^- \rightarrow Ag^0$ BALANCE $2(Ag^+ + e^- \rightarrow Ag^0) = 2\ Ag^+ + 2\ e^- \rightarrow 2\ Ag^0$*

6. $Pb + 2\ Ag^+ \rightarrow Pb^{2+} + 2\ Ag$

7. *The above balanced equation shows conservation of mass because there are 2 moles of silver on each sides of the equation, and 1 mole of lead on each side of the equation. It shows conservation of charge because the sum of the charges on the left side is (+2), and the sum of the charges on the right side is (+2). Both sides of the equation have the same net charge. In addition, from the balanced half-reactions, we see the electrons lost by Pb^0 is equal to the electrons gained by Ag^+.*

Equation #5: $Zn + Cr^{3+} \rightarrow Zn^{2+} + Cr$

1. *Zinc goes from 0 to +2 and chromium goes from +3 to 0. The changes in oxidation state indicate a redox reaction occurred.*

2. *Zinc is losing electrons, while chromium is gaining electrons.*

3. *Zinc is oxidized because the oxidation number increases, meaning electrons are lost. Chromium is reduced because the oxidation number decreases, meaning electrons are gained.*

4. *Zn^0 is the reducing agent (because it is oxidized) and Cr^{3+} is the oxidizing agent (because it is reduced).*

5. *Half reactions:*
   a. *Oxidation: $Zn^0 \rightarrow Zn^{2+} + 2\ e^-$ BALANCE $3(Zn^0 \rightarrow Zn^{2+} + 2\ e^-) = 3\ Zn^0 \rightarrow 3\ Zn^{2+} + 6\ e^-$*
   b. *Reduction: $Cr^{3+} + 3\ e^- \rightarrow Cr^0$ BALANCE $2(Cr^{3+} + 3e^- \rightarrow Cr^0) = 2\ Cr^{3+} + 6\ e^- \rightarrow 2\ Cr^0$*

6. $3\ Zn + 2\ Cr^{3+} \rightarrow 3\ Zn^{2+} + 2\ Cr$

7. *The above balanced equation shows conservation of mass because there are 2 moles of chromium on each sides of the equation, and 3 moles of zinc on each side of the equation. It shows conservation of charge because the sum of the charges on the left side is (+6), and the sum of the charges on the right side is (+6). Both sides of the equation have the same net charge. In addition, from the balanced half-reactions, we see the electrons lost by Zn^0 is equal to the electrons gained by Cr^{3+}.*

Equation #6: $Ag^+ + Ni \rightarrow Ag + Ni^{2+}$

1. *Nickel goes from 0 to +1 and silver goes from +1 to 0. The changes in oxidation state indicate a redox reaction occurred.*

2. *Nickel is losing electrons, while silver is gaining electrons.*

3. *Nickel is oxidized because the oxidation number increases, meaning electrons are lost. Silver is reduced because the oxidation number decreases, meaning electrons are gained.*

4. *Ni^0 is the reducing agent (because it is oxidized) and Fe^{3+} is the oxidizing agent (because it is reduced).*

5. *Half reactions:*
   a. *Oxidation: $Ni^0 \rightarrow Ni^{2+} + 2\ e^-$ BALANCE no balancing needed = $Ni^0 \rightarrow Ni^{2+} + 2\ e^-$*
   b. *Reduction: $Ag^+ + e^- \rightarrow Ag^0$ BALANCE $2(Ag^+ + e^- \rightarrow Ag^0) = 2\ Ag^+ + 2\ e^- \rightarrow 2\ Ag^0$*

6. *$Ni + 2\ Ag^+ \rightarrow Ni^{2+} + 2\ Ag$*

7. *The above balanced equation shows conservation of mass because there are 2 silver of iron on each sides of the equation, and 1 mole of nickel on each side of the equation. It shows conservation of charge because the sum of the charges on the left side is (+2), and the sum of the charges on the right side is (+2). Both sides of the equation have the same net charge. In addition, from the balanced half-reactions, we see the electrons lost by Ni^0 is equal to the electrons gained by Ag^+.*

Equation #7: $Cu^{2+} + Fe \rightarrow Cu + Fe^{3+}$

1. *Iron goes from 0 to +3 and copper goes from +2 to 0. The changes in oxidation state indicate a redox reaction occurred.*

2. *Iron is losing electrons, while copper is gaining electrons.*

3. *Iron is oxidized because the oxidation number increases, meaning electrons are lost. Copper is reduced because the oxidation number decreases, meaning electrons are gained.*

4. *Fe^0 is the reducing agent (because it is oxidized) and Cu^{2+} is the oxidizing agent (because it is reduced).*

5. *Half reactions:*
    a. *Oxidation: $Fe^0 \rightarrow Fe^{3+} + 3\ e^-$ BALANCE $2(Fe^0 \rightarrow Fe^{3+} + 3\ e^-) = 2\ Fe^0 \rightarrow 2\ Fe^{3+} + 6\ e^-$*
    b. *Reduction: $Cu^{2+} + 2\ e^- \rightarrow Cu^0$ BALANCE $3(Cu^{2+} + 2\ e^- \rightarrow Cu^0) = 3\ Cu^{2+} + 6\ e^- \rightarrow 3\ Cu^0$*

6. *$2\ Fe + 3Cu^{2+} \rightarrow 2\ Fe^{3+} + 3\ Cu$*

7. *The above balanced equation shows conservation of mass because there are 2 moles of iron on each sides of the equation, and 3 moles of copper on each side of the equation. It shows conservation of charge because the sum of the charges on the left side is (+6), and the sum of the charges on the right side is (+6). Both sides of the equation have the same net charge. In addition, from the balanced half-reactions, we see the electrons lost by Fe^0 is equal to the electrons gained by Cu^{2+}.*

Equation #8: $Cu + Al^{3+} \rightarrow Cu^{2+} + Al$

1. *Copper goes from 0 to +2 and aluminum goes from +3 to 0. The changes in oxidation state indicate a redox reaction occurred.*

2. *Copper is losing electrons, while aluminum is gaining electrons.*

3. *Copper is oxidized because the oxidation number increases, meaning electrons are lost. Aluminum is reduced because the oxidation number decreases, meaning electrons are gained.*

4. *Cu^0 is the reducing agent (because it is oxidized) and Al^{3+} is the oxidizing agent (because it is reduced).*

5. *Half reactions:*
    a. *Oxidation: $Cu^0 \rightarrow Cu^{2+} + 2\ e^-$ BALANCE $3(Cu^0 \rightarrow Cu^{2+} + 2\ e^-) = 3\ Cu^0 \rightarrow 3\ Cu^{2+} + 6\ e^-$*
    b. *Reduction: $Al^{3+} + 3\ e^- \rightarrow Al^0$ BALANCE $2(Al^{3+} + 3e^- \rightarrow Al^0) = 2\ Al^{3+} + 6\ e^- \rightarrow 2\ Al^0$*

6. *$3\ Cu + 2\ Al^{3+} \rightarrow 3\ Cu^{2+} + 2\ Al$*

7. *The above balanced equation shows conservation of mass because there are 2 moles of aluminum on each sides of the equation, and 3 moles of copper on each side of the equation. It shows conservation of charge because the sum of the charges on the left side is (+6), and the sum of the charges on the right side is (+6). Both sides of the equation have the same net charge. In addition, from the balanced half-reactions, we see the electrons lost by Cu^0 is equal to the electrons gained by Al^{3+}.*