Math Tutor BALANCING REDOX EQUATIONS

A redox equation must conserve both mass and charge. So, to balance a redox equation, you must balance both atoms and charge (electrons). The problem-solving tips and sample below show how to balance an equation for a redox reaction in *basic* solution.

Problem-Solving TIPS

To balance redox equations for reactions in *basic* solution:

- Add OH^- and H_2O to balance oxygen and hydrogen in the redox half-reactions.
- Add OH^- ions to the side of the equation that needs oxygen atoms. Make sure you add enough OH^- ions so that the number of oxygen atoms added is twice the number needed.
- Then, add enough H_2O molecules to the other side of the equation to balance the hydrogen atoms.

SAMPLE

The following unbalanced equation represents a redox reaction that takes place in a basic solution containing KOH. Balance the redox equation.

$$Br_2(l) + KOH(aq) \longrightarrow KBr(aq) + KBrO_3(aq)$$

Write the full ionic equation, assign oxidation numbers, and eliminate species whose oxidation numbers do not change. The result is the following equation:

$$\overset{0}{Br_2} \longrightarrow \overset{-1}{Br^-} + \overset{+5}{BrO_3^-}$$

Divide this equation into half-reactions. Note that Br_2 is the reactant in both half-reactions.

Reduction: $Br_2 \longrightarrow Br^-$ Oxidation: $Br_2 \longrightarrow BrO_3^-$

Add H_2O and OH^- to balance atoms in basic solution. Then, add electrons to balance charge.

Reduction: $Br_2 + 2e^- \longrightarrow 2Br^-$ (no need to add H_2O or OH^-)

Oxidation: $12OH^- + Br_2 \longrightarrow 2BrO_3^- + 6H_2O + 10e^-$

To balance transferred electrons, you must multiply the reduction half-reaction by 5 so that both reactions have $10e^-$.

$$5 \times (Br_2 + 2e^- \longrightarrow 2Br^-) = 5Br_2 + 10e^- \longrightarrow 10Br^-$$

Combining the two half-reactions gives

$$5Br_2 + 12OH^- + Br_2 + 10e^- \longrightarrow 10Br^- + 2BrO_3^- + 6H_2O + 10e^-$$

Canceling common species gives

$$6Br_2 + 12OH^- \longrightarrow 10Br^- + 2BrO_3^- + 6H_2O$$

Returning the potassium ions to the equation gives

$$6Br_2 + 12KOH \longrightarrow 10KBr + 2KBrO_3 + 6H_2O, \text{ or } 3Br_2 + 6KOH \longrightarrow 5KBr + KBrO_3 + 3H_2O$$

PRACTICE PROBLEMS

1. Balance the following equation for a redox reaction that takes place in basic solution:
$MnO_2(s) + NaClO_3(aq) + NaOH(aq) \longrightarrow NaMnO_4(aq) + NaCl(aq) + H_2O(l)$

2. Balance the following equation for a redox reaction that takes place in basic solution:
$N_2O(g) + KClO(aq) + KOH(aq) \longrightarrow KCl(aq) + KNO_2(aq) + H_2O(l)$