Worksheet to teach balancing equations: Redox reactions in acidic and basic medium

Name _____

Directions:

1. Start Internet Explorer or Netscape and go to www.dorjegurung.com/chemistry/IB_year1/balancing_equation_games/index.htm.
2. Click 'Directions'. Read and understand the directions.
3. Click 'OK'.
4. Click on 'Redox reactions in acidic and basic mediums.'
5. Try entering some numbers in the text boxes in front of each molecule. What happens?
6. If you forget the directions, click on the 'How to Play the Game' link. Click 'OK' when you finish reading them to return to the game.
7. When you think you have typed the right numbers in all the boxes, click the 'Balanced' button.
8. If you didn't get it right, try again.
9. If you did get it right, then fill in the correct answers on this worksheet for #1.
10. Repeat steps 7-9 for the rest of the questions that appear in the game.
11. Now do the rest of problems on this worksheet that don't appear in the game. You can draw the molecules just like the program did to figure out the answer. (Do not worry about getting the diagram of the molecules correct at this time.)

Questions

The equations that appear in the game are listed below. Do two things:

1. Fill in the blanks below as you go through the game. This is so I have a record that you did your assignment, and
2. determine the oxidation states of all the atoms involved and identify oxidation, reduction, oxidizing agent, and reducing agent.

1. $\_\_ Cr_2O_7^{2-}{}_{(aq)} + \_\_ I^-{}_{(aq)} + \_\_\_ H^+{}_{(aq)} \rightarrow \_\_\_ Cr^{3+}{}_{(aq)} + \_\_\_ IO_3^-{}_{(aq)} + \_\_\_ H_2O_{(l)}$

2. $\_\_ I_{2\,(s)} + \_\_ OCl^-{}_{(aq)} + \_\_\_ H_2O_{(l)} \rightarrow \_\_\_ IO_3^-{}_{(aq)} + \_\_\_ Cl^-{}_{(aq)} + \_\_\_ H^+{}_{(aq)}$

3. $\_\_ As_2O_{3\,(s)} + \_\_ NO_3^-{}_{(aq)} + \_\_ H_2O_{(l)} + \_\_ H^+{}_{(aq)} \rightarrow \_\_ H_3AsO_4^-{}_{(aq)} + \_\_ N_2O_{3\,(aq)}$

4. $\_\_ MnO_4^-{}_{(aq)} + \_\_ Br^-{}_{(aq)} + \_\_ H_2O_{(l)} \rightarrow \_\_ MnO_{2\,(s)} + \_\_ BrO_3^-{}_{(aq)} + \_\_ OH^-{}_{(aq)}$

5. __ $Pb(OH)_4^{2-}{}_{(aq)}$ + __ $ClO^-{}_{(aq)}$ → __ $PbO_{2\ (s)}$ + __ $Cl^-{}_{(aq)}$ + __ $OH^-{}_{(aq)}$ + __ $H_2O_{\ (l)}$

Notice how the reactions above involve hydrogen and hydroxide ions and water. In general, readox reactions in acidic medium will also involve hydrogen ions and water, while those in basic solution will involve hydroxide ions and water.

Often, you will only be told that the redox reaction takes place in acidic or basic medium, from which you are to deduce that whether hydrogen ions or hydroxide ions are involved. Depending on whether the redox reaction takes place in acidic or basic medium, slightly different method has to be employed.

Balancing a Redox reaction in either acidic or basic medium

Method 1: Half-equation method

Step 1. Identify and write the incomplete half-reactions.

Step 2. Balance just the elements other than O and H (and charges).

Step 3. Balance O by adding H_2O and then balance H atoms using one of the following methods:

In the case of an acidic medium reaction: by adding H^+.

In the case of a basic medium reaction: by adding H_2O and countering the O atoms by adding the same number of OH^- on the other side.

Step 4. Balance electric charge by adding electrons.

Step 5. Ensure extent of oxidation is equal to the extent of reduction and combine the balanced half-equations.

Method 2: Oxidation state method

Step 1. Balancing the *total change* in oxidation numbers by adding coefficients in front of the reducing and oxidizing agents.

Step 2. Balancing charges by adding H^+ or OH^- ions, depending on the medium.

Step 3. Balancing excess hydrogen and oxygen by adding H_2O.

Show the steps involved in balancing the above redox reactions using the half-equation method. (Eliminate hydrogen or hydroxide ion and water from the equation first.)

Balance the following equations using the half-equation method. Show every step involved. If you need assistance go to www.dorjegurung.com.np/chemistry/IB_year1/index.htm and check out Activities and Demonstration under Stoichiometry and Reactions. (Oxidation state of oxygen in hydrogen peroxide is "–1").

6. $Cr_2O_7^{2-}{}_{(aq)}$ + $NO_2^-{}_{(aq)}$ → $Cr^{3+}{}_{(aq)}$ + $NO_3^-{}_{(aq)}$ (acidic medium)
7. $As_{(s)}$ + $ClO_3^-{}_{(aq)}$ → $H_3AsO_{3\ (aq)}$ + $HClO_{(aq)}$ (acidic medium)
8. $MnO_4^-{}_{(aq)}$ + $Cl^-{}_{(aq)}$ → $Mn^{2+}{}_{(aq)}$ + $Cl_{2\ (aq)}$ (acidic medium)
9. $H_2O_{2\ (aq)}$ + $ClO_{2\ (aq)}$ → $ClO_2^-{}_{(aq)}$ + $O_{2\ (g)}$ (basic medium)
10. $H_2O_{2\ (aq)}$ + $Cl_2O_{7\ (aq)}$ → $ClO_2^-{}_{(aq)}$ + $O_{2\ (g)}$ (basic medium)

Solutions

1. 1,1,8,2,1,4
2. 1, 5,1,2,5,2
3. 1,2,2,2,2,1
4. 2,1,1,2,1,2
5. 1,1,1,1,2,1
6. $Cr_2O_7^{2-}{}_{(aq)} + 3\ NO_2^-{}_{(aq)} + 8\ H^+{}_{(aq)} \rightarrow 2\ Cr^{3+}{}_{(aq)} + 3\ NO_3^-{}_{(aq)} + 4\ H_2O_{(l)}$
7. $4As_{(s)} + 3ClO_3^-{}_{(aq)} + 6H_2O_{(l)} + 3H^+{}_{(aq)} \rightarrow 4H_3AsO_{3\ (aq)} + 3HClO_{(aq)}$
8. $2MnO_4^-{}_{(aq)} + 10Cl^-{}_{(aq)} + 16H^+{}_{(aq)} \rightarrow 2Mn^{2+}{}_{(aq)} + 5Cl_{2\ (aq)} + 8H_2O_{(aq)}$
9. $H_2O_{2\ (aq)} + 2ClO_{2\ (aq)} + 2OH^-{}_{(aq)} \rightarrow 2ClO_2^-{}_{(aq)} + O_{2\ (g)} + 2H_2O_{(l)}$
10. $6H_2O_{2\ (aq)} + Cl_2O_{7\ (aq)} + 2OH^-{}_{(aq)} \rightarrow 2ClO_2^-{}_{(aq)} + 6O_{2\ (g)} + 7H_2O_{(l)}$