Academic Chemistry Half-Reaction Method Wkst Name:_____

Balance the following redox reaction using the half-reaction method. Identify the oxidizing agent (OA), the reducing agent (RA), the element oxidized, and the element reduced.

Acidic Solution Problems

1. $\overset{0}{Ag} + \overset{+5}{NO_3^-} \rightarrow \overset{+1}{Ag^+} + \overset{+2}{NO}$

$3(Ag \rightarrow Ag^+ + e^-)$

$3e^- + NO_3^- + 4H^+ \rightarrow NO + 2H_2O$

$3Ag + 3e^- + NO_3^- + 4H^+ \rightarrow 3Ag^+ + 3e^- + NO + 2H_2O$

Element Oxidized Ag Element Reduced N RA Ag OA N

Correct Equation: $3Ag + NO_3^- + 4H^+ \rightarrow 3Ag^+ + NO + 2H_2O$

2. $\overset{-2}{\overset{+1}{C_2H_4}} + \overset{+7}{\overset{-2}{MnO_4^-}} \rightarrow \overset{+2}{Mn^{2+}} + \overset{+4}{\overset{-2}{CO_2}}$

$(C_2H_4 + 4H_2O \rightarrow 2CO_2 + 12H^+ + 12e^-)\ 5$

$(5e^- + MnO_4^- + 8H^+ \rightarrow Mn^{2+} + 4H_2O)\ 12$

$5C_2H_4 + 20H_2O + 60e^- + 12MnO_4^- + 96H^+ \rightarrow 10CO_2 + 60H^+ + 60e^- + 12Mn^{2+} + 48H_2O$

$96H^+ - 60H^+ = 36H^+$ $\quad 48H_2O - 20H_2O = 28H_2O$

Element Oxidized C Element Reduced Mn RA C OA Mn

Correct Equation: $5C_2H_4 + 12MnO_4^- + 36H^+ \rightarrow 10CO_2 + 12Mn^{2+} + 28H_2O$

3. $\overset{-2}{H_2S} + \overset{0}{I_2} \rightarrow \overset{0}{S} + \overset{-1}{I^-}$

$H_2S \rightarrow S + 2H^+ + 2e^-$

$I_2 + 2e^- \rightarrow 2I^-$

$H_2S + I_2 + \cancel{2e^-} \rightarrow S + 2I^- + 2H^+ + \cancel{2e^-}$

Element Oxidized S Element Reduced I RA S OA I

Correct Equation: $H_2S + I_2 \rightarrow S + 2I^- + 2H^+$

4. $\overset{+5}{UF_6^-} + \overset{-1}{H_2O_2} \rightarrow \overset{+6}{UO_2^{2+}} + \overset{-1}{HF}$

Element Oxidized _____ Element Reduced _____ RA _____ OA _____

Correct Equation:

5. $\overset{2}{Fe^{2+}} + \overset{7}{MnO_4^-} \rightarrow \overset{3}{Fe^{3+}} + \overset{2}{Mn^{2+}}$

$(Fe^{2+} \rightarrow Fe^{3+} + e^-)\,5$

$5e^- + MnO_4^- + 8H^+ \rightarrow Mn^{2+} + 4H_2O$

$5Fe^{2+} + \cancel{5e^-} + MnO_4^- + 8H^+ \rightarrow Fe^{3+} + \cancel{5e^-} + Mn^{2+} + 4H_2O$

Element Oxidized Fe Element Reduced Mn RA Fe OA Mn

Correct Equation: $5Fe^{2+} + MnO_4^- + 8H^+ \rightarrow Fe^{3+} + Mn^{2+} + 4H_2O$

6. $\overset{+4}{PbO_2} + \overset{-1}{Cl^-} \rightarrow \overset{+2}{Pb^{2+}} + \overset{0}{Cl_2}$

$2\,Cl^- \rightarrow Cl_2 + 2e^-$

$2e^- + PbO_2 + 4H^+ \rightarrow Pb^{2+} + 2H_2O$

$2Cl^- + 2e^- + PbO_2 + 4H^+ \rightarrow Cl_2 + 2e^- + Pb^{2+} + 2H_2O$

Element Oxidized Cl Element Reduced Pb RA Cl OA Pb

Correct Equation: $PbO_2 + 2Cl^- + 4H^+ \rightarrow Pb^{2+} + Cl_2 + 2H_2O$

7. $\overset{6}{Cr_2O_7^{2-}} + \overset{-1}{I^-} \rightarrow \overset{3}{Cr^{3+}} + \overset{0}{I_2}$

$3(2\,I^- \rightarrow I_2 + 2e^-)$

$6e^- + Cr_2O_7^{2-} + 14H^+ \rightarrow 2Cr^{3+} + 7H_2O$

$6I^- + 6e^- + Cr_2O_7^{2-} + 14H^+ \rightarrow 3I_2 + 6e^- + 2Cr^{3+} + 7H_2O$

Element Oxidized I Element Reduced Cr RA I OA Cr

Correct Equation: $Cr_2O_7^{2-} + 6I^- + 14H^+ \rightarrow 2Cr^{3+} + 3I_2 + 7H_2O$

8. $\overset{2}{Fe^{2+}} + \overset{6}{Cr_2O_7^{2-}} \rightarrow \overset{3}{Fe^{3+}} + \overset{3}{Cr^{3+}}$

$6(Fe^{2+} \rightarrow Fe^{3+} + 1e^-)$

$6e^- + Cr_2O_7^{2-} + 14H^+ \rightarrow Cr^{3+} + 7H_2O$

$6Fe^{2+} + 6e^- + Cr_2O_7^{2-} + 14H^+ \rightarrow 6Fe^{3+} + 6e^- + Cr^{3+} + 7H_2O$

Element Oxidized Fe Element Reduced Cr RA Fe OA Cr

Correct Equation: $6Fe^{2+} + Cr_2O_7^{2-} + 14H^+ \rightarrow 6Fe^{3+} + Cr^{3+} + 7H_2O$

9. $I_2 + H_3AsO_3 \rightarrow I^- + H_3AsO_4$

(0 → −1; 3 → 5)

$H_3AsO_3 + H_2O \rightarrow H_3AsO_4 + 2H^+ + 2e^-$

$I_2 + 2e^- \rightarrow 2I^-$

$H_3AsO_3 + H_2O + I_2 + \cancel{2e^-} \rightarrow H_3AsO_4 + 2H^+ + \cancel{2e^-} + 2I^-$

Element Oxidized As Element Reduced I RA As OA I

Correct Equation: $I_2 + H_3AsO_3 + H_2O \rightarrow H_3AsO_4 + 2I^- + 2H^+$

Basic Solution Problems

10. $Br_2 \rightarrow BrO_3^- \quad Br^-$

(0 → 5; 0 → −1)

$Br_2 + 6H_2O \rightarrow 2BrO_3^- + 12H^+ + 10e^-$

$(Br_2 + 2e^- \rightarrow 2Br^-)5$

$Br_2 + 6H_2O + 5Br_2 + \cancel{10e^-} + 12OH^- \rightarrow 2BrO_3^- + \cancel{12H^+} + \cancel{10e^-} + 10Br^- + \cancel{12OH^-}$

$(6Br_2 + \cancel{6H_2O} + 12OH^- \rightarrow 2BrO_3^- + \cancel{6H_2O} + 10Br^-) \div 2$

Element Oxidized Br Element Reduced Br RA Br OA Br

Correct Equation: $3Br_2 + 6OH^- \rightarrow BrO_3^- + 5Br^- + 3H_2O$

11. $CN^- + MnO_4^- \rightarrow CNO^- + MnO_2$

(+2 → +4; +7 → +4)

$(CN^- + H_2O \rightarrow CNO^- + 2H^+ + 2e^-)3$

$(3e^- + MnO_4^- + 4H^+ \rightarrow MnO_2 + 2H_2O)2$

$3CN^- + \cancel{3H_2O} + \cancel{6e^-} + 2MnO_4^- + \cancel{8H^+} \rightarrow 3CNO^- + \cancel{6H^+} + \cancel{6e^-} + 2MnO_2 + \cancel{4H_2O}$

$3CN^- + 2MnO_4^- + 2H^+ + 2OH^- \rightarrow 3CNO^- + 2MnO_2 + \cancel{H_2O} + 2OH^-$

($2H^+ + 2OH^- \rightarrow 2H_2O$)

Element Oxidized C Element Reduced Mn RA C OA Mn

Correct Equation: $3CN^- + 2MnO_4^- + H_2O \rightarrow 3CNO^- + 2MnO_2 + 2OH^-$

12. $CrO_4^{2-} + HSnO_2^- \rightarrow HSnO_3^- + CrO_2^-$ (6, 2, 4, 3)

$(HSnO_2^- + H_2O \rightarrow HSnO_3^- + 2H^+ + 2e^-)3$

$(3e^- + CrO_4^{2-} + 4H^+ \rightarrow CrO_2^- + 2H_2O)2$

$3HSnO_2^- + 3H_2O + 6e^- + 2CrO_4^{2-} + 8H^+ \rightarrow 3HSnO_3^- + 6H^+ + 6e^- + 2CrO_2^- + 4H_2O$

$3HSnO_2^- + 2CrO_4^{2-} + 2H^+ + 2OH^- \rightarrow 3HSnO_3^- + 2CrO_2^- + H_2O + 2OH^-$

($2H^+ + 2OH^- \rightarrow 2H_2O$)

Element Oxidized Sn Element Reduced Cr RA Sn OA Cr

Correct Equation: $2CrO_4^{2-} + 3HSnO_2^- + H_2O \rightarrow 3HSnO_3^- + 2CrO_2^- + 2OH^-$

13. $H_2O_2 + ClO_2^- \rightarrow ClO_2^- + O_2$ (-1, 4, 3, 0)

$H_2O_2 \rightarrow O_2 + 2H^+ + 2e^-$

$(ClO_2 + 1e^- \rightarrow ClO_2^-)2$

$H_2O_2 + 2ClO_2 + 2e^- \rightarrow O_2 + 2H^+ + 2e^- + 2ClO_2^- + 2OH^-$

($2OH^-$)

Element Oxidized O Element Reduced Cl RA O OA Cl

Correct Equation: $H_2O_2 + 2ClO_2 + 2OH^- \rightarrow O_2 + 2ClO_2^- + 2H_2O$

Neutral Solution Problems

14. $Fe^{3+} + I^- \rightarrow Fe^{2+} + I_2$ (3, -1, 2, 0)

$2I^- \rightarrow I_2 + 1e^-$

$Fe^{3+} + 1e^- \rightarrow Fe^{2+}$

$2I^- + Fe^{3+} + 1e^- \rightarrow I_2 + 1e^- + Fe^{2+}$

Element Oxidized I Element Reduced Fe RA I OA Fe

Correct Equation: $Fe^{3+} + 2I^- \rightarrow Fe^{2+} + I_2$