Half-Box Method

Guidelines for Balancing Redox Reactions

1. Assign oxidation numbers to each element in the reaction

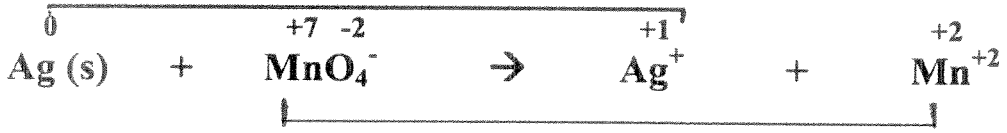
   Review of rules: a. elements = 0 b. ions = charge, c. elements in cpds F = -1, O = -2, H = +1 d. in cpds the oxid #'s of all elements must add up to = 0
   e. in polyions the oxid #'s of all elements must add up to = the charge of the ion

$$\overset{0}{Ag\,(s)} + \overset{+7\ -2}{MnO_4^-} \rightarrow \overset{+1}{Ag^+} + \overset{+2}{Mn^{+2}}$$

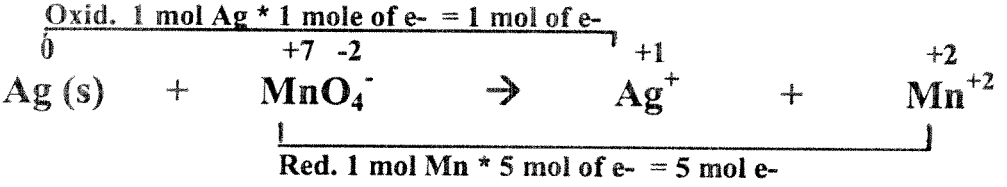
2. Once oxidation numbers are determined, analyze the #'s to see which element is being oxidized and which element is being reduced (remember oxidized means the oxid # goes up and reduced means the oxid # goes down).

Ag is being oxid. from 0 to +1 and Mn is being red. from +7 to +2

3. Then draw a ½ rectangle box on the top of the reaction from the element being oxidized on the left to its new self on the right. Next draw a ½ rectangle box on the bottom of the reaction from the element being reduced on the left to its new self on the right.



4. Next count the number of things being oxidized on each side as well as the number of electrons transferred (based upon the oxidation # change) and say # moles of element * # moles of electrons transferred = moles of electrons transferred. Repeat this process for the reduction part putting this equation on the top side or bottom side of the appropriate ½ box.



5. The number of electrons transferred must be equal so the two numbers must be multiplied together using ( ) and the number in ( ) must be applied (multiplied) onto the existing coefficients that the appropriate ½ box is pointed to on each side.

Oxid. 1 mol Ag * 1 mole of e- = 1 mol of e- (5) = 5 mole e-

$$\overset{0}{5Ag\,(s)} + \overset{+7\ -2}{1\ MnO_4^-} \rightarrow \overset{+1}{5\ Ag^+} + \overset{+2}{1\ Mn^{+2}}$$

Red. 1 mol Mn * 5 mol of e- = 5 mol e- (1) = 5 mol e-

6. Finally add the needed number of H_2O's to the side with either no oxygens or less oxygens so that the oxygens are balanced. Then add H^+ to the side with no hydrogens or less hydrogens to balance the hydrogens.

$$5Ag\,(s) + 1\ MnO_4^- + 8H^+ \rightarrow 5\ Ag^+ + 1\ Mn^{+2} + 4H_2O\,(l)$$

7. *If* the reaction happens to take place in ***Basic*** solution instead of acidic solution do this last thing: Add to each side the same number of OH^- that you have of H^+ and then combine the OH^- with the H^+ that are on the same side to make H_2O on one side and then cancel out the same number of H_2O on each side as a clean up.

$$5Ag\,(s) + MnO_4^- + 8H^+ + 8OH^- \rightarrow 5\ Ag^+ + Mn^{+2} + 4H_2O\,(l) + 8OH^-$$

$$5Ag\,(s) + MnO_4^- + 8H_2O\,(l) \rightarrow 5\ Ag^+ + Mn^{+2} + 4H_2O\,(l) + 8OH^-$$

$$5Ag\,(s) + MnO_4^- + 4H_2O\,(l) \rightarrow 5\ Ag^+ + Mn^{+2} + 8OH^-$$