BALANCING REDOX REACTIONS

ACIDIC SOLUTIONS

1. Divide reaction into half reactions. $Cr20.2-+Mn^{2+} -> Cr^{3+} + Mn04^{1-}$

$$Cr_2O_7^{2-} \rightarrow Cr^{3+}$$
 and $Mn^{2+} \rightarrow MnO_4^{1-}$

2. Balance all other elements except for H & 0.

$$Cr_20, 2 \rightarrow 2 Cr_3 + Mn_2 + \rightarrow Mn_041$$

3. Balance 0 by adding H20.

$$Cr_20$$
, 2 -> $2Cr^{3+}$ + $7H20$ Mn^2 + $4H20$ -> $MnO4^1$ -

4. Balance H by adding H⁺.

$$Cr_20$$
, 2- + 14 H + -> 2 $Cr3+$ + 7 H20 Mn2+ + 4 H20 -> MnO4¹- + 8 H +

5. Balance charge by adding electrons (e-) to the side that has more positive charge;

$$(-2 + + 14 = + 12)$$
 $(+6 + 0 = +6)$
 $Cr_20, 2 + 14H + + 6 e \cdot -> 2Cr_3 + + 7H_2O$
 $(+2 + 0 = + 2)$ $(-1 + +8 = +7)$
 $Mn^2 + + 4H_2O -> MnO4^1 - + SH + + Se^{-1}$

6. }/fake e- gain = e- loss. Multiply first reaction by 5 so (6 x 5 e· = 30 e-) and the second reaction by 6 so (5 x 6 e· = 30 e-).

$$5 \text{ Cr} 20,2- + 70 \text{ H}^+ + 30 \text{ e}^- -> 10 \text{ Cr} 3+ + 35 \text{ H} 20$$

 $6 \text{ Mn} 2+ + 24 \text{ H} 20 -> 6 \text{ Mn} 04^{1-} + 48 \text{ H}^+ + 30 \text{ e}^-$

7. Add reactions together and cancel like species on both sides of the reaction.

$$5 \text{ Cr} 20,2^{-} + 22 \text{ H}^{+} + 6 \text{ M} \text{ n}^{2} + -> 10 \text{ Cr}^{3+} + 11 \text{ H}_{2}\text{O} + 6 \text{ M} \text{n} \text{O}_{4}^{1-}$$

BASIC SOLUTIONS

8. If the reaction SPECIFICALLY states that the reaction occurs in basic solution, FIRST follow steps 1 through 7 for acidic solutions. THEN, convert to basic solutions by adding the same quantity of hydroxide ion (OH-) to both sides of the reaction to equal the quantity of hydrogen ion present (H⁺).

$$2 \text{ CrO}_4^{2-} + 3 \text{ Mn}^{2+} + 4 \text{ H}^+ -> 2 \text{ H}_2\text{O} + 2 \text{ Cr}^{3+} + 3 \text{ MnO}_2$$

THUS:
 $2 \text{ CrO}_4^{2-} + 3 \text{ Mn}^{2+} + 4 \text{ H}^+ + 4 \text{ OH}_{--} > 2 \text{ H}_2\text{O} + 2 \text{ Cr}^{3+} + 3 \text{ Mn} + 4 \text{ OH}_{--}$

9. Combine the H+ and OH- ion tog ther to form water.

$$2 \text{ CrO}_4^{2-} + 3 \text{ Mn}^{2+} + 4 \text{ H}_2\text{O} \rightarrow 2 \text{ H}_2\text{O} + 2 \text{ Cr}^{3+} + 3 \text{ MnO}_2 + 4 \text{ OH}^{-}$$

10. Cancel out water to obtain final reaction.

$$2 \text{ CrO}_4^{2-} + 3 \text{ Mn}^{2+} + 2 \text{ H}_2\text{O} \rightarrow 2 \text{ Cr}^{3+} + 3 \text{ MnO}_2 + 4 \text{ OH}^{-}$$