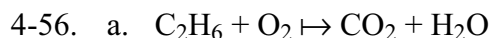


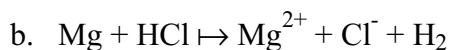
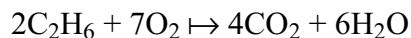
CHEM131 HOMEWORK #6 KEY

- 4-55. a. yes, O<sub>2</sub> is ox. agt., CH<sub>4</sub> is red. agt., CH<sub>4</sub> is ox. (C), O<sub>2</sub> is red.  
 b. yes, HCl is ox. agt., Zn is red. agt., Zn is ox., HCl (H) is red.  
 c. no  
 d. yes, O<sub>3</sub> like O<sub>2</sub> has zero o.s. so one atom of O<sub>3</sub> is red. and O<sub>3</sub> is ox. agt. NO is red. agt. and NO (N) is ox.  
 e. yes, one O in HOOH is ox. and one is red. so HOOH is reduced, oxidized, is the ox. agt. and red. agt.  
 f. yes, here Cu is both oxidized and reduced and is both ox agt. and red.agt.  
 g. no  
 h. no  
 i. yes, SiCl<sub>4</sub> is ox. agt., Mg is red. agt., Mg is ox. and SiCl<sub>4</sub> (Si) is red.

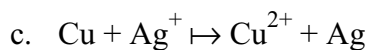


C o.s. -3 ⇌ +4, a change of +7; O o.s. 0 ⇌ -2, a change of -2; so 3.5 O's needed for each C

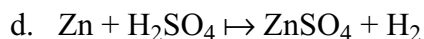
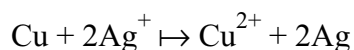
C<sub>2</sub>H<sub>6</sub> + 3.5O<sub>2</sub> ⇌ CO<sub>2</sub> + H<sub>2</sub>O is starting point; now do rest by inspection



Mg o.s. 0 ⇌ +2, a change of +2; H o.s. +1 ⇌ 0, a change of -1; so 2 H's for each Mg



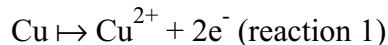
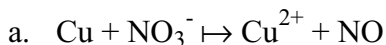
As in b. we need 2 Ag for each Cu



This one is already balanced with 2 H's required for each Zn

- 4-57. The basic procedure here is to write each half reaction, add H<sub>2</sub>O's to balance O atoms, add H<sup>+</sup>'s to balance H atoms and add e<sup>-</sup> to balance charges. Then combine the half

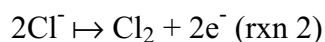
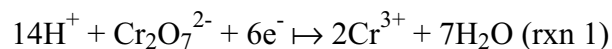
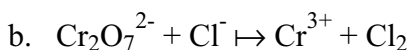
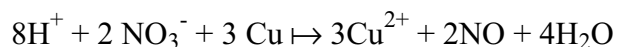
reactions in simple multiples so the  $e^-$ 's cancel and cancel any extra  $H_2O$ 's and  $H^+$ 's. As I do the various examples I will gradually provide fewer details.



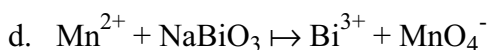
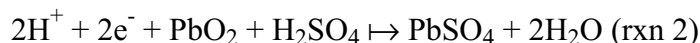
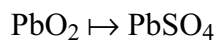
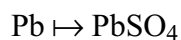
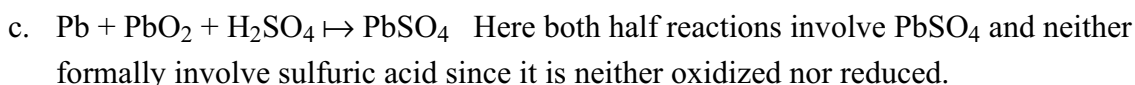
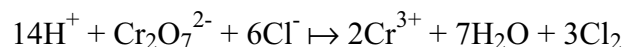
$NO_3^- \mapsto NO$ , add  $H_2O$ 's to balance O's, add  $H^+$  to balance H's, add  $e^-$  to balance charge

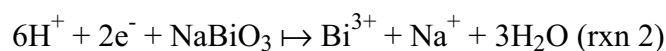
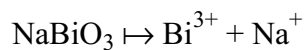
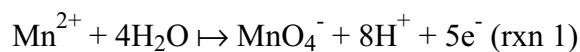
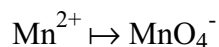


multiply (rxn 1) times 3 and (rxn 2) times 2 and add (this cancels the electrons)

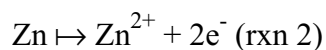
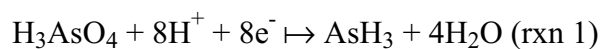
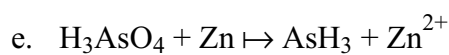
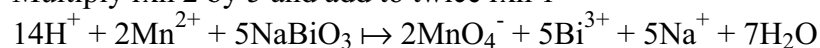


Multiply (rxn 2) by 3 and add to (rxn 1)

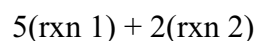
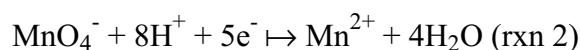
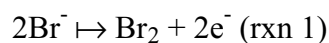
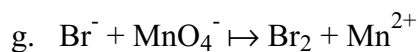
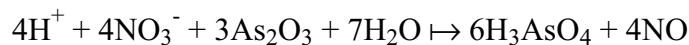
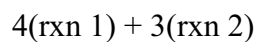
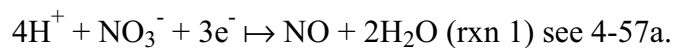
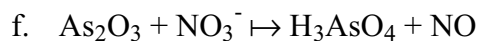
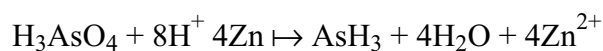


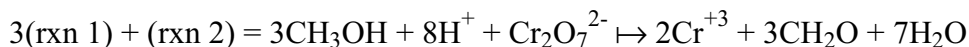
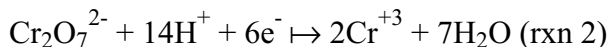
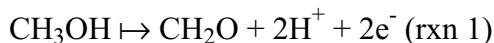
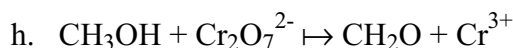
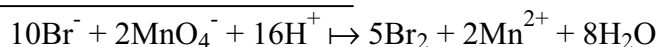


Multiply rxn 2 by 5 and add to twice rxn 1

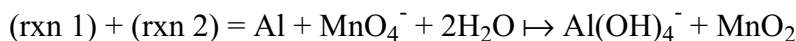
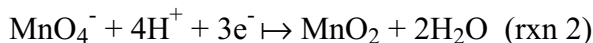
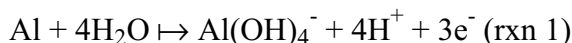
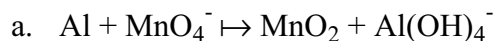


Multiply rxn 2 by 4 and add rxn 1

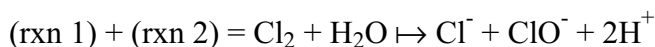
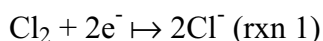
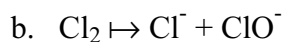




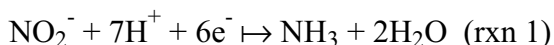
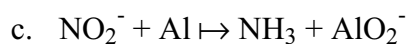
4-58. The procedure here is the same as for acidic solutions, as in problem 5-57, but at the end you neutralize all of the  $\text{H}^+$  ions with  $\text{OH}^-$  ions.

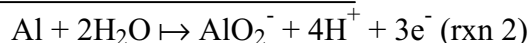


This one is a bit anticlimatic since  $\text{H}^+$  doesn't appear in the balanced equation and nothing special is needed to handle the basic medium.

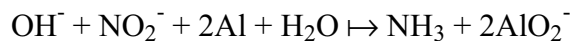


neutralizing the  $\text{H}^+$  with  $\text{OH}^-$  gives:  $\text{Cl}_2 + \text{H}_2\text{O} + 2\text{OH}^- \mapsto \text{Cl}^- + \text{ClO}^- + 2\text{H}_2\text{O}$



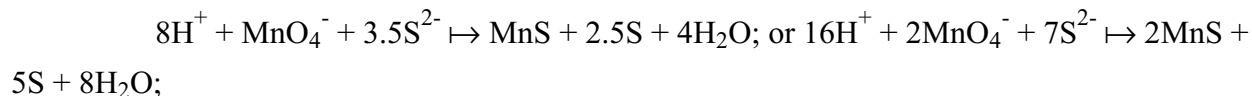


(rxn 1) + 2(rxn 2) =  $\text{NO}_2^- + 2\text{Al} + 2\text{H}_2\text{O} \mapsto \text{NH}_3 + 2\text{AlO}_2^- + \text{H}^+$ ; make basic with  $\text{OH}^-$

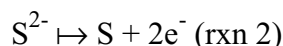
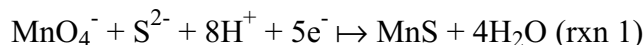


- d.  $\text{MnO}_4^- + \text{S}^{2-} \mapsto \text{MnS} + \text{S}$ ; This looks pretty simple, let's try to do it empirically rather than follow the half reaction recipe. We need 4O's on the r.h.s. so add 4H<sub>2</sub>O's there and 8H<sup>+</sup>'s on the l.h.s.

$8\text{H}^+ + \text{MnO}_4^- + \text{S}^{2-} \mapsto \text{MnS} + \text{S} + 4\text{H}_2\text{O}$ ; Now try to balance charge by multiplying  $\text{S}^{2-}$  by an appropriate number. This can work because we have the neutral S atom to balance the S's. 3.5 is the needed coefficient



make basic by adding 16 OH<sup>-</sup> to both sides and get 8 waters on the left  
 $8\text{H}_2\text{O} + 2\text{MnO}_4^- + 7\text{S}^{2-} \mapsto 2\text{MnS} + 5\text{S} + 16\text{OH}^-$ ; This works, but that was lucky and certainly not very general. Now lets do the half rxns:



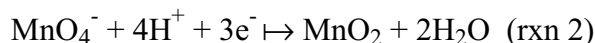
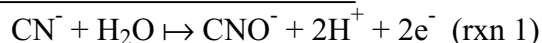
2(rxn 1) + 5(rxn 2) gets us to where we were above, just before making the system basic.

Since we are beating this problem to death with a large stick, let's try the oxidation state method

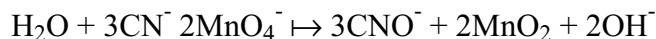
Mn o.s. +9  $\mapsto$  +2, a change of -7; S o.s. -2  $\mapsto$  0, a change of +2; so we need 3.5 S<sup>2-</sup>'s for each Mn, then add H<sub>2</sub>O's and H<sup>+</sup>'s to balance.

$8\text{H}^+ + \text{MnO}_4^- + 3.5\text{S}^{2-} \mapsto \text{MnS} + 2.5\text{S} + 4\text{H}_2\text{O}$  This looks familiar, and note that the charge automatically balances if you do the oxidation states correctly.

- e.  $\text{CN}^- + \text{MnO}_4^- \mapsto \text{CNO}^- + \text{MnO}_2$



3(rxn 1) + 2(rxn 2) followed by making basic gives:



- 4-60. a. All 3 are redox reactions.
- b. In the first rxn, N goes from -3 to +2 and O goes from 0 to -2. In the second rxn, N goes from +2 to +4 while the O in  $\text{O}_2$  goes from 0 to -2. In the third rxn, N goes from +4 to +5 in  $\text{HNO}_3$  and from +4 to +2 in  $\text{NO}$  while O and H stay the same. So N(+4) is both the oxidizing and reducing agent in this rxn.
- c. 4 moles of  $\text{NH}_3$  are required for each 5 moles of  $\text{O}_2$ . 5.0 million g of  $\text{NH}_3 = 2.9 \times 10^5$  mol  $\text{NH}_3$  and 50 million g of  $\text{O}_2 = 1.6 \times 10^6$  mol  $\text{O}_2$ . This means  $\text{NH}_3$  is the limiting reagent since only  $1.25 \times 2.9 \times 10^5 = 3.6 \times 10^5$  mole  $\text{O}_2$  are required. Since 1 mole of  $\text{NO}$  is generated for each mole of  $\text{NH}_3$ ,  $2.9 \times 10^5$  mol  $\text{NO}$  can be produced, which equals  $(2.9 \times 10^5 \text{ mol NO})(30 \text{ g NO/mol NO}) = 8.7 \times 10^6 \text{ g NO}$ .

4-65. First you need a balanced equation and either method may be used to find:

$8\text{H}^+ + \text{MnO}_4^- + 5\text{Fe}^{2+} \mapsto 5\text{Fe}^{3+} + \text{Mn}^{2+} + 4\text{H}_2\text{O}$ ; so one mole of permanganate reacts with 5 moles of  $\text{Fe}^{2+}$

38.37 mL of 0.0198 M  $\text{KMnO}_4$  solution contains  $7.597 \times 10^{-4}$  M  $\text{MnO}_4^-$  which will react with  $5 \times 7.597 \times 10^{-4} = 3.80 \times 10^{-3}$  M  $\text{Fe}^{2+}$  which equals 0.212 g Fe.  $100(0.212/0.6128) = 34.6\%$ .

H.W. Ch. 5: 22, 31, 36, 40, 42