Balancing Equations

1) For each of the following equations, identify [a] the element which was oxidized, [b] the element which was reduced, [c] the oxidizing agent, and [d] the reducing agent.

   a. $2\ ZnS + 3O_2 \rightarrow 2\ ZnO + 2\ SO_2$

   b. $2\ Fe + 3C\ell_2 \rightarrow 2\ FeC\ell_3$

   c. $3\ NaNO_3 + 2Fe \rightarrow 3\ NaNO_2 + Fe_2O_3$

   d. $3\ Cu + 8\ H^+ + 2\ NO_3^- \rightarrow 3\ Cu^{2+} + 2NO + 4H_2O$

   e. $4\ MnO_2 + 3O_2 + 4\ OH^- \rightarrow 4\ MnO_4^- + 2\ H_2O$

2) Balance the following redox reaction equations using the oxidation number method.

   a. _____ Cu + _____ H^+ + ___ $SO_4^{2-} \rightarrow$ __ Cu^{2+} + _____ SO_2 + _____ H_2O

   b. _____ Ag + _____ H^+ + _____ $NO_3^- \rightarrow$ _____ Ag^+ + _____ NO + _____ H_2O

   c. _____ I^- + _____ $Cr_2O_7^{2-}$ + _____ $H^+ \rightarrow$ _____ Cr^{3+} + _____ I_2 + _____ H_2O

   d. ____ $Cr_2O_7^{2-}$ + ____ Fe^{2+} + ____ $H^+ \rightarrow$ ____ Cr^{3+} + ____ Fe^{3+} + ____ H_2O

   e. ____ Fe^{2+} + ____ MnO_4^- + ____ $H^+ \rightarrow$ ____ Fe^{3+} + ____ Mn^{2+} + ____ H_2O

   f. ____ BiO_3^- + ____ MnO_2 + ____ $H^+ \rightarrow$ ____ Bi^{3+} + ____ MnO_4^- + ____ H_2O

   g. _____ C + _____ $H_2SO_4 \rightarrow$ _____ CO_2 + _____ SO_2 + _____ H_2O

   h. ____ MnO_4^- + ____ S^{2-} + ____ $H_2O \rightarrow$ ____ MnO_2 + ____ SO_3^{2-} + ____ OH^-

   i. _____ HNO_3 + _____ $HI \rightarrow$ _____ NO + _____ I_2 + _____ H_2O

   j. ____ CrO_4^{2-} − + ____ NH_3 + ____ $H_2O \rightarrow$ ____ NO_3^- + ____ OH^- + ____ Cr^{3+}

   k. _____ KI + _____ $H_2SO_4 \rightarrow$ _____ H_2S + _____ H_2O + _____ I_2 + _____ K_2SO_4

   l. ____ $KMnO_4$ + ____ $HC\ell \rightarrow$ ____ $MnCl_2$ + ____ Cl_2 + ____ H_2O + ____ KCl

3) Write a balanced equation for each of the following half-reactions, and state whether it represents oxidation or reduction.

   a. $NO_3^- \rightarrow NH_4^+$ (acidic)

   b. $Ag_2O_3 \rightarrow AgO$ (basic)

   c. $AsH_3 \rightarrow H_3AsO_3$ (acidic)

   d. $N_2O \rightarrow NH_3OH^+$ (acidic)

   e. $CrO_4^{2-} \rightarrow Cr(OH)_3$ (basic)

   f. $Br_2 \rightarrow BrO_3^-$ (acidic)

4) Balance the following redox equations:

a. $ClO_3^- + N_2H_4 \rightarrow NO + Cl^-$

b. $MnO_4^- + C_2O_4^{2-} \rightarrow MnO_2 + CO_3^{2-}$(basic)

c. $Sb + NO_3^- \rightarrow Sb_2O_5 + NO$ (acidic)

d. $IPO_4 \rightarrow I_2 + IO_3^- + H_2PO_4^-$ (basic)

e. $Cr_2O_7^{2-} + C_2O_4^{2-} \rightarrow Cr^{3+} + CO_2$(acidic)

f. $As \rightarrow AsH_3 + H_2AsO_4^-$ (basic)

5) Balance the following redox reaction equations

1) ___ H_3PO_4 + ___ KOH → ___ K_3PO_4 + ___ H_2O

2) ___ K + ___ B_2O_3 → ___ K_2O + ___ B

3) ___ HCl + ___ NaOH → ___ NaCl + ___ H_2O

4) ___ Na + ___ $NaNO_3$ → ___ Na_2O + ___ N_2

5) ___ C + ___ S_8 → ___ CS_2

6) ___ Na + ___ O_2 → ___ Na_2O

7) ___ N_2 + ___ O_2 → ___ N_2O_5

8) ___ H_3PO_4 + ___ $Mg(OH)_2$ → ___ $Mg_3(PO_4)_2$ + ___ H_2O

9) ___ NaOH + ___ H_2CO_3 → ___ Na_2CO_3 + ___ H_2O

10) ___ KOH + ___ HBr → ___ KBr + ___ H_2O

11) ___ Na + ___ O_2 →___ Na_2O

12) ___ Al $(OH)_3$ + ___ H_2CO_3 →___ $Al_2(CO_3)_3$ + ___ H_2O

13) ___ Al + ___ S_8 → ___ Al_2S_3

14) ___ Cs + ___ N_2 →___ Cs_3N

15) ___ Mg + ___ Cl_2 → ___ $MgCl_2$

16) ___ Rb + ___ $RbNO_3$ → ___ Rb_2O + ___ N_2

17) ___ C_6H_6 + ___ O_2 → ___ CO_2 + ___ H_2O

18) ___ N_2 + ___ H_2 → ___ NH_3

19) ___ $C_{10}H_{22}$ + ___ O_2 → ___ CO_2 + ___ H_2O

20) ___ $Al(OH)_3$ + ___ HBr → ___ $AlBr_3$ + ___ H_2O

21) ___ $CH_3CH_2CH_2CH_3$ + ___ O_2 → ___ CO_2 + ___ H_2O

22) ___ C_3H_8 + ___ O_2 → ___ CO_2 + ___ H_2O

23) ___ Li + ___ $AlCl_3$ → ___ LiCl + ___ Al

24) ___ C_2H_6 + ___ O_2 → ___ CO_2 + ___ H_2O

25) ___ NH_4OH + ___ H_3PO_4 → ___ $(NH_4)_3PO_4$ + ___ H_2O

26) ___ Rb + ___ P → ___ Rb_3P

27) ___ CH_4 + ___ O_2 → ___ CO_2 + ___ H_2O

28) ___ $Al(OH)_3$ + ___ H_2SO_4 → ___ $Al_2(SO_4)_3$ + ___ H_2O

29) ___ Na + ___ Cl_2 → ___ NaCl

30) ___ Rb + ___ S_8 → ___ Rb_2S

31) ___ H_3PO_4 + ___ $Ca(OH)_2$ → ___ $Ca_3(PO_4)_2$ + ___ H_2O

32) ___ NH_3 + ___ HCl → ___ NH_4Cl

33) ___ Li + ___ H_2O → ___ LiOH + ___ H_2

34) ___ $Ca_3(PO_4)_2$ + ___ SiO_2 + ___ C → ___ $CaSiO_3$ + ___ CO + ___ P

35) ___ NH_3 + ___ O_2 → ___ N_2 + ___ H_2O

36) ___ FeS_2 + ___ O_2 → ___ Fe_2O_3 + ___ SO_2

37) ___ C + ___ SO_2 →___ CS_2 + ___ CO

6) For each of the following, separate the skeletal (unbalanced) equation into two half reactions. For each half reaction, balance the elements (mass balance), and then add electrons to the right or left side to make a net charge balance. Identify which half reaction is the oxidation and which is the reduction. Then, multiply each half reaction by an appropriate factor so that the two multiplied half reactions add together to make a balanced redox equation.

a. $Hg_2^{2+} + S_2O_3^{2-} \rightarrow Hg + S_4O_6^{2-}$

b. $Al + Cr^{3+} \rightarrow Al^{3+} + Cr^{2+}$

c. $Au^{3+} + I^- \rightarrow Au + I_2$

7) Use the ion-electron method to complete and balance the following skeletal redox equations, occurring in either acidic or basic aqueous solution, as indicated. Identify the oxidation and reduction half reactions in each case.

a. In acid, $Cu + NO_3^- \rightarrow Cu^{2+} + N_2O_4$

b. In acid, $XeO_3 + BrO_3^- \rightarrow Xe + BrO_4^-$

c. In acid, $MnO_4^- + CH_3OH \rightarrow Mn^{2+} + HCO_2H$

d. In acid, $Cr_2O_7^{2-} + I_2 \rightarrow Cr^{3+} + IO_3^-$

e. In base, $PbOH_4^- + ClO^- \rightarrow PbO_2 + Cl^-$

f. In base, $SO_2 + MnO_4^- \rightarrow SO_4^{2-} + MnO_2$

8) Balance the following redox reactions in an acidic solution.

a. $Fe^{2+}_{(aq)} + MnO_4^-{}_{(aq)} \rightarrow Fe^{3+}_{(aq)} + Mn^{2+}_{(aq)}$

b. $Cr_2O_7^{2-}{}_{(aq)} + Cl^-_{(aq)} \rightarrow Cr^{3+}_{(aq)} + Cl_{2(aq)}$

c. $Mn^{2+}_{(aq)} + ClO_3^-{}_{(aq)} \rightarrow MnO_{2(s)} + ClO_{2(aq)}$

d. $Cr_2O_7^{2-}{}_{(aq)} + Fe^{2+}_{(aq)} \rightarrow Cr^{3+}_{(aq)} + Fe^{3+}_{(aq)}$