Summary: P810 # 1-18

1)
a) N_2, M = 14.01 g/mol X 2 = 28.02 g/mol
b) C_8H_{18} = 12.01 g/mol X 8 + 1.01 g/mol X 18 = 114.26 g/mol
c) O_2 = 16.00 g/mol X 2 = 32.00 g/mol
d) $Ni(NO_3)_2$ = 58.71 g/mol + 14.01 g/mol X 2 + 16.00 g/mol X 6 = 182.83 g/mol
e) $Zn(HCO_3)_2$ = 65.38 + 1.01 X 2 + 12.01 X 2 + 16.00 X 6 = 187.42 g/mol
f) $CuSO_4$•$5H_2O$ = 63.55 + 32.07 + 16.00 X 9 + 1.01 X 10 = 249.72 g/mol
g) He = 4.00 g/mol
h) SO_3 = 32.07 + 16.00 X 3 = 80.07 g/mol
i) NH_3 = 14.01 + 1.01 X 3 = 17.04 g/mol
j) HCl = 1.01 + 35.45 = 36.46 g/mol

2)
a) Cl_2, Cl: 3.0 X 2 = 6.0 mol
b) $Fe(NO_3)_3$, Fe: 2.0 mol; N: 2.0 X 3 = 6.0 mol; O: 2.0 X 9 = 18.0 mol
c) $K_2Cr_2O_7$, K: 4.5 X 2 = 9.0 mol; Cr: 4.5 X 2 = 9.0 mol; O: 4.5 mol X 7 = 31.5 mol
d) N_2, N: 1.5 X 2 = 3.0 mol
e) $(NH_4)_2SO_4$, N: 5.0 X 2 = 10.0 mol; H: 5.0 X 8 = 40.0 mol; S: 5.0 mol; O; 5.0 X 4 = 20.0 mol

3) NOTE: I use a program to calculate molar masses from this point on. Some of the atomic masses it uses are slightly different than the ones in the periodic table at the back of your textbook; therefore, some of the molar masses you see here may differ slightly from the ones you calculate using the periodic table at the back of your textbook.
a) $Mg(OH)_2$, M = 58.32 g/mol; m = 2.5 mol X 58.32 g/mol = 1.5 X 10^2 g
b) $C_6H_{12}O_6$, M = 180.16 g/mol; m = 0.25 mol X 180.16 g/mol = 45 g
c) O_2, M = 32.00 g/mol; m = 0.00675mol X 32.00 g/mol = 0.216 g
d) Cu, M = 63.55 g/mol, n = 1.20 X 10^{24}atoms / 6.02 X 10^{23} atoms/mol = 1.99 mol, m = 126 g
e) CH_4, M = 16.04 g/mol, n = 3.01 X 10^{22} molecules / 6.02 X 10^{23} molecules/mol = 0.0500 mol, m = 0.802 g

4)
a) H_2O, M = 18.02 g/mol, n = 10.00 g / 18.02 g/mol = 0.5549 mol
b) Al_2O_3, M = 101.96 g/mol, n = 1.50 X 10^3 g / 101.96 g/mol = 14.7 mol
c) Na_3PO_4, M = 163.94 g/mol, n = 0.00235 g / 163.94 g/mol = 1.43 X 10^{-5} mol
d) H_2, M = 2.02 g/mol, n = 1.20 X 10^{-5} g / 2.02 g/mol = 5.94 X 10^{-6} mol
e) CO_2, M = 44.01 g/mol,n = 1.00 X 10^{25} molecules / 6.02 X 10^{23} molecules/mol = 16.6 mol

5)
a) assume exactly 1 mol of material
H_2SO_4 M = 98.07 g/mol
percentage 2H = 2.02 g / 98.07 g X 100% = 2.06 %

percentage S = 32.07 g / 98.07 g X 100% = 32.70%
percentage 4O = 64.00 g / 98.07 g X 100% = 65.26%
b) 2.50 g is irrelevant information, assume exactly 1 mol of material
$AgNO_3$, M= 169.87 g/mol
percentage Ag = 107.87 / 169.87 X 100% = 63.502%
percentage N = 14.01 / 169.87 X 100% = 8.247%
percentage 3O = 48.00 / 169.87 X 100% = 28.26%
c) assume exactly 1 mol of material
NH_4NO_3, M = 80.04 g/mol
percentage 2N = 28.02 / 80.04 X 100% = 35.01%
percentage 4H = 4.04 / 80.04 X 100% = 5.05%
percentage 3O = 48.00 / 80.04 X 100% = 59.97%

6) Assume exactly 100 g of material. Calculate 'ratio of n' by dividing all 'n' values by the smallest of the 'n' values.
a)

Atom	mass (g)	n (mol)	ratio of n
N	36.8	2.62	1.0
O	63.2	3.95	1.5

Therefore, empirical formula is N_2O_3
b) M of empirical formula = 76.01 g/mol. Since this equals M of molecular formula, then molecular formula must be N_2O_3.

7)

Atom	mass (g)	n (mol)	ratio of n
H	16.0	15.8	2.0
C	96.0	7.99	1.0

Therefore, empirical formula is CH_2, M_e = 14.03 g/mol
ration of M_m/M_e = 28.06 g/mol/14.03 g/mol = 2
Therefore, molecular formula is C_2H_4

8)
a) $2NH_{3(g)} + 5/2O_{2(g)} \rightarrow 2NO_{(g)} + 3H_2O_{(l)}$
b) $3NO_{2(g)} + H_2O_{(l)} \rightarrow 2HNO_{3(aq)} + NO_{(g)}$
c) $C_{12}H_{22}O_{11(s)} + 12O_{2(g)} \rightarrow 12CO_{2(g)} + 11H_2O_{(l)}$
d) $2KClO_{3(s)} \rightarrow 2KCl_{(s)} + 3O_{2(g)}$
e) $MnO_{2(s)} + 4HCl_{(aq)} \rightarrow MnCl_{2(aq)} + Cl_{2(g)} + 2H_2O_{(l)}$
f) $2Al_2O_{3(s)} \rightarrow 4Al_{(s)} + 3O_{2(g)}$
g) $Ni_{(s)} + A2gNO_{3(aq)} \rightarrow 2Ag_{(s)} + Ni(NO_3)_{2(aq)}$
h) $3KOH_{(aq)} + H_3PO_{4(aq)} \rightarrow K_3PO_{4(aq)} + 3H_2O_{(l)}$

9)
a) $P_4 + 5O_2 \rightarrow 2P_2O_5$
b) $Al_2(SO_4)_3 + 3Ca(OH)_2 \rightarrow 2Al(OH)_3 + 3CaSO_4$
c) $4NH_3 + 3O_2 \rightarrow 2N_2 + 6H_2O$
d) $CaCl_2 + 2HNO_3 \rightarrow Ca(NO_3)_2 + 2HCl$
e) $(NH_4)_2S + Pb(NO_3)_2 \rightarrow 2NH_4NO_3 + PbS$
f) $Al_2(SO_4)_3 + 6NH_4Br \rightarrow 2AlBr_3 + 3(NH_4)_2SO_4$
g) $2NaNO_3 \rightarrow 2NaNO_2 + O_2$
h) $2K_3PO_4 + 3MgCl_2 \rightarrow Mg_3(PO_4)_2 + 6KCl$
i) $2NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$
j) $3Hg(OH)_2 + 2H_3PO_4 \rightarrow Hg_3(PO_4)_2 + 6H_2O$

10)
a) $n(O_2)$ = 5 mol X 3/2 = 7.5 mol
b) $n(CO_2)$ = 12.5 mol X 2/2 = 12.5 mol

11)
a) $Mg + Cl_2 \rightarrow MgCl_2$
b) $M(Cl_2)$ = 70.90 g/mol; M(Mg) = 24.31 g/mol; $M(MgCl_2)$ = 95.21 g/mol
$n(Cl_2)$ = 15.00g / 70.90 g/mol = 0.2116 mol
n(Mg) = 0.2116 mol X 1/1 = 0.2116 mol
m(Mg) = 0.2116 mol X 24.31 g/mol = 5.144 g
c) $n(MgCl_2)$ = 8.00 g / 95.21 g/mol = 0.0840 mol
n (Mg) = 0.0840 mol X 1/1 = 0.0840 mol
m(Mg) = 0.0840 mol X 24.31 g/mol = 2.04 g

12)
a) $Ca(OH)_{2(s)} + Na_2CO_{3(aq)} \rightarrow 2NaOH_{(aq)} + CaCO_{3(s)}$
b) $M(Na_2CO_3)$ = 105.99 g/mol; $M(Ca(OH)_2)$ = 74.09 g/mol
$n(Ca(OH)_2)$ = 175.0 g / 74.09 g/mol = 2.362 mol
$n(Na_2CO_3)$ = 2.362 X 1/1 = 2.362 mol
$m(Na_2CO_3)$ = 2.362 mol X 105.99 g/mol = 250.3 g
c) M(NaOH) = 40.00 g/mol, n(NaOH) = 2.362 X 2/1 = 4.724 mol
m(NaOH) = 4.724 mol X 40.00 g/mol = 189.0 g

13)
a) Products should be lead metal and aqueous zinc nitrate.
b) $Zn_{(s)} + Pb(NO_3)_{2(aq)} \rightarrow Pb_{(s)} + Zn(NO_3)_{2(aq)}$
c) M(Zn) = 65.38 g/mol; M(Pb) = 207.37 g/mol
n(Zn) = 4.55 g / 65.38 g/mol = 0.0696 mol
n(Pb) = n(Zn) X 1/1 = 0.0696 mol
m(Pb) = 0.0696mol X 207.37 g/mol = 14.4 g
d) n(Pb) = 50.0 g / 207.37 g/mol = 0.241 mol

n(Zn) = n(Pb) X 1/1 = 0.241 mol
m(Zn) = 0.241 mol X 65.38 g/mol = 15.8 g

Limiting Reactant:
1) Pick a product.
2) Calculate how much of the product is produced by each of the reactants.
3) Reactant that produces least amount of product is the limiting reactant. Base all mole-mole calculations on this reactant amount.

14) Product picked is $CO_{2(g)}$

#	n($C_3H_{8(g)}$) (mol)	n($O_{2(g)}$) (mol)	n(CO_2) from propane(mol)	n(CO_2) from oxygen(mol)	Limiting Reactant
a	1	1	3	0.6	Oxygen
b	5	5	15	3	Oxygen
c	2	5	6	3	Oxygen
d	2	12	6	7.2	Propane
e	0.36	1.60	1.08	0.96	Oxygen

15)
a) $Fe_2O_{3(s)} + 3CO_{(g)} \rightarrow 2Fe_{(s)} + 3CO_{2(g)}$
Product picked is $Fe_{(s)}$
b) n(Fe) from Fe_2O_3 = 2.50 X 2/1 = 5.00 mol
n(Fe) from CO = 6.50 mol X 2/3 = 4.33 mol
Therefore, CO is limiting reactant
c) n(Fe) from Fe_2O_3 = 200.0g / 159.69 g/mol X 2/1 = 2.50 mol
n(Fe) from CO = 100.0 g / 28.01 g/mol X 2/3 = 2.38 mol
Therefore, CO is limiting reactant
d) Masses are the same as in c, therefore use CO to calculate amount of Fe producted
n (Fe) = 2.38 mol
m(Fe) = 2.38 mol X 55.85 g/mol = 133 g.

16) $AlCl_{3(aq)} + 3NaOH_{(aq)} \rightarrow Al(OH)_{3(s)} + 3NaCl_{(aq)}$
a) n($AlCl_3$) = 15.0 g / 133.34 g/mol = 0.112 mol
n(NaOH) = 15.0 g / 40.00 g/mol = 0.375 mol

n($Al(OH)_3$) from $AlCl_3$ = 0.113 mol X 1/1 = 0.113 mol
n($Al(OH)_3$) from NaOH = 0.375 mol X 1/3 = 0.125 mol
Therefore, $AlCl_3$ is limiting reactant, NaOH is in excess
m($Al(OH)_3$) = 0.113 mol X 78.00 = 8.81 g
b) n(NaOH) consumed = 0.112 X 3/1 = 0.336

n(NaOH) in excess = 0.375 mol - 0.336 mol = 0.039 mol
m(NaOH) = 0.039 mol X 40.00 g/mol = 1.56 g

17)
$SiO_2 + 4HF \rightarrow SiF_4 + 2H_2O$
a)
$n(SiO_2)$ = 15.00 g / 60.08 g/mol = 0.2497 mol
$n(SiF_4) = n(SiO_2)$ X 1/1 = 0.2497 mol
$m(SiF_4)$ = 0.2497 mol X 104.08 g/mol = 25.99 g
b) % yield = 17.92 g / 25.99 g X 100% = 68.95 %

18)
a) $Zn + 2HCl \rightarrow H_2 + ZnCl_2$
Product chosen is H_2
$n(H_2)$ from Zn = 8.40 g / 65.38 g/mol X 1/1 = 0.129 mol
$n(H_2)$ from HCl = 11.6 g / 36.46 g/mol X ½ = 0.159 mol
Therefore, Zn is limiting reactant
$m(H_2)$ = 0.129 mol X 2.02 g/mol = 0.261 g
b) %yield = 0.19 g / 0.261 g X 100% = 73%