

Summary: P810 # 1-18

1)

- a) N_2 , $M = 14.01 \text{ g/mol} \times 2 = 28.02 \text{ g/mol}$
- b) $\text{C}_8\text{H}_{18} = 12.01 \text{ g/mol} \times 8 + 1.01 \text{ g/mol} \times 18 = 114.26 \text{ g/mol}$
- c) $\text{O}_2 = 16.00 \text{ g/mol} \times 2 = 32.00 \text{ g/mol}$
- d) $\text{Ni}(\text{NO}_3)_2 = 58.71 \text{ g/mol} + 14.01 \text{ g/mol} \times 2 + 16.00 \text{ g/mol} \times 6 = 182.83 \text{ g/mol}$
- e) $\text{Zn}(\text{HCO}_3)_2 = 65.38 + 1.01 \times 2 + 12.01 \times 2 + 16.00 \times 6 = 187.42 \text{ g/mol}$
- f) $\text{CuSO}_4 \cdot 5\text{H}_2\text{O} = 63.55 + 32.07 + 16.00 \times 9 + 1.01 \times 10 = 249.72 \text{ g/mol}$
- g) $\text{He} = 4.00 \text{ g/mol}$
- h) $\text{SO}_3 = 32.07 + 16.00 \times 3 = 80.07 \text{ g/mol}$
- i) $\text{NH}_3 = 14.01 + 1.01 \times 3 = 17.04 \text{ g/mol}$
- j) $\text{HCl} = 1.01 + 35.45 = 36.46 \text{ g/mol}$

2)

- a) Cl_2 , $\text{Cl}: 3.0 \times 2 = 6.0 \text{ mol}$
- b) $\text{Fe}(\text{NO}_3)_3$, $\text{Fe}: 2.0 \text{ mol}$; $\text{N}: 2.0 \times 3 = 6.0 \text{ mol}$; $\text{O}: 2.0 \times 9 = 18.0 \text{ mol}$
- c) $\text{K}_2\text{Cr}_2\text{O}_7$, $\text{K}: 4.5 \times 2 = 9.0 \text{ mol}$; $\text{Cr}: 4.5 \times 2 = 9.0 \text{ mol}$; $\text{O}: 4.5 \text{ mol} \times 7 = 31.5 \text{ mol}$
- d) N_2 , $\text{N}: 1.5 \times 2 = 3.0 \text{ mol}$
- e) $(\text{NH}_4)_2\text{SO}_4$, $\text{N}: 5.0 \times 2 = 10.0 \text{ mol}$; $\text{H}: 5.0 \times 8 = 40.0 \text{ mol}$; $\text{S}: 5.0 \text{ mol}$; $\text{O}: 5.0 \times 4 = 20.0 \text{ mol}$

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) $\text{Mg}(\text{OH})_2$, $M = 58.32 \text{ g/mol}$; $m = 2.5 \text{ mol} \times 58.32 \text{ g/mol} = 1.5 \times 10^2 \text{ g}$
- b) $\text{C}_6\text{H}_{12}\text{O}_6$, $M = 180.16 \text{ g/mol}$; $m = 0.25 \text{ mol} \times 180.16 \text{ g/mol} = 45 \text{ g}$
- c) O_2 , $M = 32.00 \text{ g/mol}$; $m = 0.00675 \text{ mol} \times 32.00 \text{ g/mol} = 0.216 \text{ g}$
- d) Cu , $M = 63.55 \text{ g/mol}$, $n = 1.20 \times 10^{24} \text{ atoms} / 6.02 \times 10^{23} \text{ atoms/mol} = 1.99 \text{ mol}$, $m = 126 \text{ g}$
- e) CH_4 , $M = 16.04 \text{ g/mol}$, $n = 3.01 \times 10^{22} \text{ molecules} / 6.02 \times 10^{23} \text{ molecules/mol} = 0.0500 \text{ mol}$, $m = 0.802 \text{ g}$

4)

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

5)

- a) assume exactly 1 mol of material
 H_2SO_4 $M = 98.07 \text{ g/mol}$
percentage $2\text{H} = 2.02 \text{ g} / 98.07 \text{ g} \times 100\% = 2.06 \%$

percentage S = $32.07 \text{ g} / 98.07 \text{ g} \times 100\% = 32.70\%$

percentage 4O = $64.00 \text{ g} / 98.07 \text{ g} \times 100\% = 65.26\%$

b) 2.50 g is irrelevant information, assume exactly 1 mol of material

AgNO_3 , $M = 169.87 \text{ g/mol}$

percentage Ag = $107.87 / 169.87 \times 100\% = 63.502\%$

percentage N = $14.01 / 169.87 \times 100\% = 8.247\%$

percentage 3O = $48.00 / 169.87 \times 100\% = 28.26\%$

c) assume exactly 1 mol of material

NH_4NO_3 , $M = 80.04 \text{ g/mol}$

percentage 2N = $28.02 / 80.04 \times 100\% = 35.01\%$

percentage 4H = $4.04 / 80.04 \times 100\% = 5.05\%$

percentage 3O = $48.00 / 80.04 \times 100\% = 59.97\%$

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)

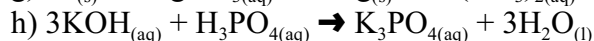
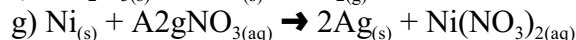
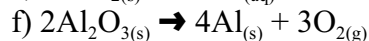
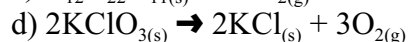
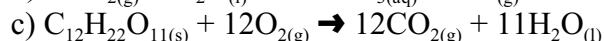
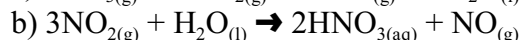
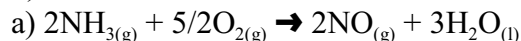
| Atom | mass (g) | n (mol) | ratio of n |
|------|----------|---------|------------|
| H | 16.0 | 15.8 | 2.0 |
| C | 96.0 | 7.99 | 1.0 |

Therefore, empirical formula is CH_2 , $M_e = 14.03 \text{ g/mol}$

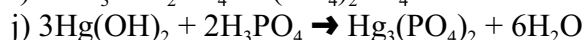
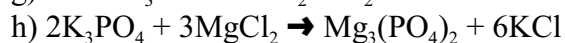
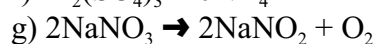
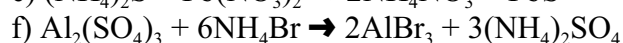
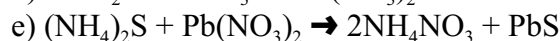
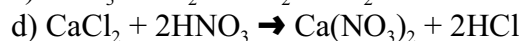
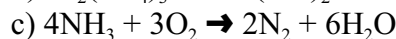
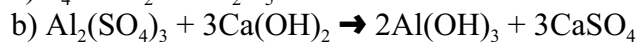
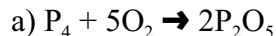
ratio of $M_m/M_e = 28.06 \text{ g/mol} / 14.03 \text{ g/mol} = 2$

Therefore, molecular formula is C_2H_4

8)



9)

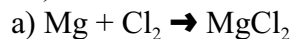


10)

a) $n(\text{O}_2) = 5 \text{ mol} \times 3/2 = 7.5 \text{ mol}$

b) $n(\text{CO}_2) = 12.5 \text{ mol} \times 2/2 = 12.5 \text{ mol}$

11)



b) $M(\text{Cl}_2) = 70.90 \text{ g/mol}$; $M(\text{Mg}) = 24.31 \text{ g/mol}$; $M(\text{MgCl}_2) = 95.21 \text{ g/mol}$

$n(\text{Cl}_2) = 15.00 \text{ g} / 70.90 \text{ g/mol} = 0.2116 \text{ mol}$

$n(\text{Mg}) = 0.2116 \text{ mol} \times 1/1 = 0.2116 \text{ mol}$

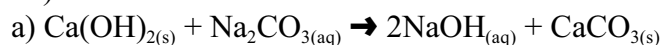
$m(\text{Mg}) = 0.2116 \text{ mol} \times 24.31 \text{ g/mol} = 5.144 \text{ g}$

c) $n(\text{MgCl}_2) = 8.00 \text{ g} / 95.21 \text{ g/mol} = 0.0840 \text{ mol}$

$n(\text{Mg}) = 0.0840 \text{ mol} \times 1/1 = 0.0840 \text{ mol}$

$m(\text{Mg}) = 0.0840 \text{ mol} \times 24.31 \text{ g/mol} = 2.04 \text{ g}$

12)



b) $M(\text{Na}_2\text{CO}_3) = 105.99 \text{ g/mol}$; $M(\text{Ca}(\text{OH})_2) = 74.09 \text{ g/mol}$

$n(\text{Ca}(\text{OH})_2) = 175.0 \text{ g} / 74.09 \text{ g/mol} = 2.362 \text{ mol}$

$n(\text{Na}_2\text{CO}_3) = 2.362 \times 1/1 = 2.362 \text{ mol}$

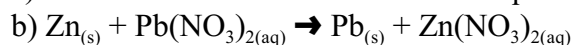
$m(\text{Na}_2\text{CO}_3) = 2.362 \text{ mol} \times 105.99 \text{ g/mol} = 250.3 \text{ g}$

c) $M(\text{NaOH}) = 40.00 \text{ g/mol}$, $n(\text{NaOH}) = 2.362 \times 2/1 = 4.724 \text{ mol}$

$m(\text{NaOH}) = 4.724 \text{ mol} \times 40.00 \text{ g/mol} = 189.0 \text{ g}$

13)

a) Products should be lead metal and aqueous zinc nitrate.



c) $M(\text{Zn}) = 65.38 \text{ g/mol}$; $M(\text{Pb}) = 207.37 \text{ g/mol}$

$n(\text{Zn}) = 4.55 \text{ g} / 65.38 \text{ g/mol} = 0.0696 \text{ mol}$

$n(\text{Pb}) = n(\text{Zn}) \times 1/1 = 0.0696 \text{ mol}$

$m(\text{Pb}) = 0.0696 \text{ mol} \times 207.37 \text{ g/mol} = 14.4 \text{ g}$

d) $n(\text{Pb}) = 50.0 \text{ g} / 207.37 \text{ g/mol} = 0.241 \text{ mol}$

$$n(\text{Zn}) = n(\text{Pb}) \times 1/1 = 0.241 \text{ mol}$$

$$m(\text{Zn}) = 0.241 \text{ mol} \times 65.38 \text{ g/mol} = 15.8 \text{ g}$$

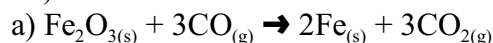
Limiting Reactant:

- 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 $\text{CO}_{2(g)}$

| # | $n(\text{C}_3\text{H}_{8(g)})$ (mol) | $n(\text{O}_{2(g)})$ (mol) | $n(\text{CO}_2)$ from propane(mol) | $n(\text{CO}_2)$ 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)



Product picked is $\text{Fe}_{(s)}$

$$\text{b) } n(\text{Fe}) \text{ from } \text{Fe}_2\text{O}_3 = 2.50 \times 2/1 = 5.00 \text{ mol}$$

$$n(\text{Fe}) \text{ from } \text{CO} = 6.50 \text{ mol} \times 2/3 = 4.33 \text{ mol}$$

Therefore, CO is limiting reactant

$$\text{c) } n(\text{Fe}) \text{ from } \text{Fe}_2\text{O}_3 = 200.0 \text{ g} / 159.69 \text{ g/mol} \times 2/1 = 2.50 \text{ mol}$$

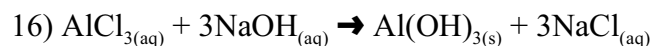
$$n(\text{Fe}) \text{ from } \text{CO} = 100.0 \text{ g} / 28.01 \text{ g/mol} \times 2/3 = 2.38 \text{ mol}$$

Therefore, CO is limiting reactant

d) Masses are the same as in c, therefore use CO to calculate amount of Fe produced

$$n(\text{Fe}) = 2.38 \text{ mol}$$

$$m(\text{Fe}) = 2.38 \text{ mol} \times 55.85 \text{ g/mol} = 133 \text{ g.}$$



$$\text{a) } n(\text{AlCl}_3) = 15.0 \text{ g} / 133.34 \text{ g/mol} = 0.112 \text{ mol}$$

$$n(\text{NaOH}) = 15.0 \text{ g} / 40.00 \text{ g/mol} = 0.375 \text{ mol}$$

$$n(\text{Al}(\text{OH})_3) \text{ from } \text{AlCl}_3 = 0.113 \text{ mol} \times 1/1 = 0.113 \text{ mol}$$

$$n(\text{Al}(\text{OH})_3) \text{ from } \text{NaOH} = 0.375 \text{ mol} \times 1/3 = 0.125 \text{ mol}$$

Therefore, AlCl_3 is limiting reactant, NaOH is in excess

$$m(\text{Al}(\text{OH})_3) = 0.113 \text{ mol} \times 78.00 = 8.81 \text{ g}$$

$$\text{b) } n(\text{NaOH}) \text{ consumed} = 0.112 \times 3/1 = 0.336$$

$$n(\text{NaOH}) \text{ in excess} = 0.375 \text{ mol} - 0.336 \text{ mol} = 0.039 \text{ mol}$$

$$m(\text{NaOH}) = 0.039 \text{ mol} \times 40.00 \text{ g/mol} = 1.56 \text{ g}$$

17)



a)

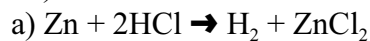
$$n(\text{SiO}_2) = 15.00 \text{ g} / 60.08 \text{ g/mol} = 0.2497 \text{ mol}$$

$$n(\text{SiF}_4) = n(\text{SiO}_2) \times 1/1 = 0.2497 \text{ mol}$$

$$m(\text{SiF}_4) = 0.2497 \text{ mol} \times 104.08 \text{ g/mol} = 25.99 \text{ g}$$

$$\text{b) \% yield} = 17.92 \text{ g} / 25.99 \text{ g} \times 100\% = 68.95 \%$$

18)

Product chosen is H_2

$$n(\text{H}_2) \text{ from Zn} = 8.40 \text{ g} / 65.38 \text{ g/mol} \times 1/1 = 0.129 \text{ mol}$$

$$n(\text{H}_2) \text{ from HCl} = 11.6 \text{ g} / 36.46 \text{ g/mol} \times 1/2 = 0.159 \text{ mol}$$

Therefore, Zn is limiting reactant

$$m(\text{H}_2) = 0.129 \text{ mol} \times 2.02 \text{ g/mol} = 0.261 \text{ g}$$

$$\text{b) \% yield} = 0.19 \text{ g} / 0.261 \text{ g} \times 100\% = 73\%$$