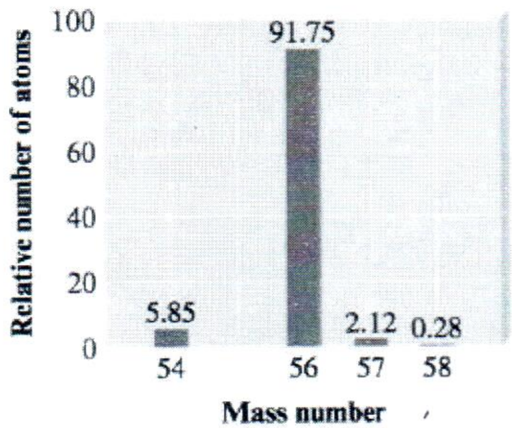
CHEM 101A – Chapter 3 Stoichiometry Problems

1. The stable isotopes of iron are ^{54}Fe, ^{56}Fe, ^{57}Fe, and ^{58}Fe. The mass spectrum of iron looks like the following:



54(.0585) =
56(.9175) =
57(.0212) =
58(.0028) =
3SF
55.9098 ~ 55.9
P.table = 55.845

Use the data from the mass spectrum to estimate the atomic mass of iron and compare to the value on the periodic table.

Sodium nitride

2. What is the percent composition of each element in Na_3N?

100-g

47.08gC 6.59gH 46.33gCl

3. A compound contains 47.08%C, 6.59%H, and 46.33%Cl by mass. The molar mass is 153g/mol. What are the empirical and molecular formulas?

$47.08\,g\,C \times \frac{1\,mol\,C}{12.01\,g\,C} = 3.920\,mol\,C / 1.307 = 2.99 \sim 3$

$6.59\,g\,H \times \frac{1\,mol\,H}{1.008\,g\,H} = 6.538\,mol\,H / 1.307 = 5$

$46.33\,g\,Cl \times \frac{1\,mol\,Cl}{35.45\,g\,Cl} = 1.307\,mol\,Cl / 1.307 = 1$

$\frac{153}{\sim 76\,g/mol} \approx 2$

C_3H_5Cl emp.

× 2

$C_6H_{10}Cl_2$ molec.

4. Balance the following equations:

lead(II) acetate potassium iodide potassium acetate

a) $Pb(C_2H_3O_2)_2(aq) + 2KI(aq) \rightarrow PbI_2(s) + 2KC_2H_3O_2(aq)$

lead(II) iodide

b) $P_4O_{10}(s) + 6H_2O(l) \rightarrow 4H_3PO_4(aq)$

phosphoric acid

tetraphophorus decoxide

5. If you react 52.9 g potassium chlorate with excess red phosphorus, what mass tetraphosphorus decoxide could be produced? The Unbalanced equation is below:

$10KClO_3(s) + 3P_4(s) \rightarrow 3P_4O_{10}(s) + 10KCl(s)$

52.9g x.s. ?g

1. Balance
2. g $KClO_3$ → mol $KClO_3$ → mol P_4O_{10} → g P_4O_{10}

$$\frac{52.9\text{ g } KClO_3}{1} \times \frac{1\text{ mol } KClO_3}{122.55\text{ g } KClO_3} \times \frac{3\text{ mol } P_4O_{10}}{10\text{ mol } KClO_3} \times \frac{283.88\text{ g } P_4O_{10}}{1\text{ mol } P_4O_{10}} = 36.8\text{ g } P_4O_{10}$$

(3) (5) exact (5)

NO! → mol

6. A 0.4230-g sample of impure sodium nitrate was heated, converting all the sodium nitrate to 0.2864 g of sodium nitrite and oxygen gas. Determine the percent sodium nitrate in the original sample.

85.00 g/mol 69.00 g/mol

$$2NaNO_3 \rightarrow 2NaNO_2 + O_2$$

? g 0.2864 g

$$0.2864\,g\,NaNO_2 \times \frac{1\,mol\,NaNO_2}{69.00\,g\,NaNO_2} \times \frac{2\,mol\,NaNO_3}{2\,mol\,NaNO_2} \times \frac{85.00\,g\,NaNO_3}{1\,mol\,NaNO_3}$$

$$= \frac{0.3528\,g\,NaNO_3}{0.4230\,g\ \text{impure}} \times 100\%$$

$$= 83.41\%\ NaNO_3$$

~2 Kg ~2 Kg

7. Consider the balanced reaction below—molar masses are provided:

react: 1.0 kg .95 kg 1.3 kg 0.63 kg

prod

310.g/mol 98.1g/mol 136g/mol 98.0g/mol

$$Ca_3(PO_4)_2(s) + 3H_2SO_4(aq) \rightarrow 3CaSO_4(s) + 2H_3PO_4(aq)$$

1.0 kg 1.0 kg 98% ? g ? g

(2)

What masses of calcium sulfate and phosphoric acid can be produced from the reaction of 1.0 kg calcium phosphate with 1.0 kg concentrated sulfuric acid (98% H_2SO_4 by mass)? State the limiting reactant.

moles reactants

$$1000\ g\ Ca_3(PO_4)_2 \times \frac{1\ mol\ Ca_3(PO_4)_2}{310.\ g\ Ca_3(PO_4)_2} = 3.23\ mol\ Ca_3(PO_4)\ \text{(L.R.)}$$

3.32 mol; ×3 = 9.69 mol → kg

$$980\ g\ H_2SO_4 \times \frac{1\ mol\ H_2SO_4}{98.1\ g\ H_2SO_4} = 9.98\ mol\ H_2SO_4$$

LR→prod.

$$3.23\ mol\ Ca_3(PO_4) \times \frac{3\ mol\ CaSO_4}{1\ mol\ Ca_3(PO_4)} \times \frac{136\ g\ CaSO_4}{1\ mol\ CaSO_4} \times \frac{1\ kg}{1000\ g} = 1.3\ kg$$

$$3.23\ mol\ Ca_3(PO_4)_2 \times \frac{2\ mol\ H_3PO_4}{1\ mol\ Ca_3(PO_4)_2} \times \frac{98.0\ g\ H_3PO_4}{1\ mol\ H_3PO_4} \times \frac{1\ kg}{1000\ g} = 0.63\ kg$$

excess

9.98 mol H_2SO_4 given
− 9.69 mol H_2SO_4 react
0.29 mol H_2SO_4 excess ⇒

0.98 kg given
0.95 kg react
0.028 kg excess