Be sure to answer all parts.

Industrially, nitric acid is produced by the Ostwald process, as represented by the following equations:

$4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(l)$

$2NO(g) + O_2(g) \rightarrow 2NO_2(g)$

$2NO_2(g) + H_2O(l) \rightarrow HNO_3(aq) + HNO_2(aq)$

What mass of NH_3 (in grams) must be used to produce 3.97 tons of HNO_3 by the Ostwald process, assuming an 80.0 percent yield in each step (1 ton = 2000 lb; 1 lb = 453.6 g)? Enter your answer in scientific notation.

☐ × 10☐ g NH_3

(molar mass of HNO_3)

$$3.97 \text{ tons of } HNO_3 \times \frac{2000\,lb}{1\,ton} \times \frac{453.6\,g}{1\,lb} \times \frac{1\,mol\,HNO_3}{63.018\,g\,HNO_3} = 5.715\times10^4\,mol\,HNO_3$$

$$5.715\times10^4\,mol\,HNO_3 \times \frac{2\,mol\,NO_2}{1\,mol\,HNO_3} \times \frac{2\,mol\,NO}{2\,mol\,NO_2} \times \frac{4\,mol\,NH_3}{4\,mol\,NO} = 1.143\times10^5\,mol\,NH_3$$

$$1.143\times10^5\,mol\,NH_3 \times \frac{17.034\,g\,NH_3}{1\,mol\,NH_3} = 1.947\times10^6\,g\,NH_3$$

if the reactions were 100% efficent, 1.947×10^6 g NH_3 would be needed to generate 3.97 tons of HNO_3. Each step yields only 80% of the theoretical amount, however. Since there are 3 steps that are 80% efficent:

$$(0.8)(0.8)(0.8) = 0.512 \quad 51.2\% \text{ total yield}$$

$$X\,g \text{ of } NH_3 \text{ Actually needed } (0.512) = 1.95\times10^6\,mol\,NH_3 \text{ theoretically needed } (1)$$

$$X\,g \text{ of } NH_3 \text{ Actually needed} = \boxed{3.79\times10^6\,g\,NH_3}$$

Enter your answer in the provided box.

Assume the atomic mass of element X is 22.99 amu. A 28.88−g sample of X combines with 100.35 g of another element Y to form a compound XY. Calculate the atomic mass of Y.

$$X + Y \longrightarrow XY$$

[ ] amu

moles of X: $28.88\,g\,X \times \dfrac{1\,mol\,X}{22.99\,g\,X} = 1.256\,mol\,X$

$$1.256\,mol\,X \times \frac{1\,mol\,Y}{1\,mol\,X} = 1.256\,mol\,Y$$

Molar mass of Y:

$$\frac{100.35\,g\,Y}{1.256\,mol\,Y} = \frac{79.90\,g\,Y}{mol} = \text{Atomic MASS}$$

(when completing the problem, you must assume that X reacts completely with Y to generate XY in 100% yield.)

3.50 Calculate the mass in grams of iodine (I_2) that will react completely with 20.4g of aluminum (Al) to form aluminum iodide.

Balanced Equation = $2Al(s) + 3I_2(s) \longrightarrow 2AlI_3(s)$

$$20.4g\ Al \times \frac{1\ mol\ Al}{26.98g\ Al} \times \frac{3\ mol\ I_2}{2\ mol\ Al} \times \frac{253.8g\ I_2}{1\ mol\ I_2} = 288g\ I_2$$

3.72 Ammonia is prepared by the reaction between hydrogen and nitrogen:

$$3H_2\ (g) + N_2\ (g) \rightarrow 2NH_3\ (g)$$

In a particular reaction, 6.0 mol of NH_3 were produced. How many moles of H_2 and how many moles of N_2 were consumed to produce this amount of NH_3?

$$6.0\ mol\ NH_3 \times \frac{3\ mol\ H_2}{2\ mol\ NH_3} = 9.0\ mol\ H_2$$

$$6.0\ mol\ NH_3 \times \frac{1\ mol\ N_2}{2\ mol\ NH_3} = 3.0\ mol\ N_2$$

3.48 The density of water is 1.00g/mL at 4 °C. How many water molecules are present in 15.78 mL of water at this temperature?

$$15.78\ mL \times \frac{1.00g}{mL} = 15.78g \times \frac{1\ mol\ H_2O}{18.02g\ H_2O} \times \frac{6.022 \times 10^{23}\ molecules}{1\ mol\ H_2O}$$

$$= 5.275 \times 10^{23}\ molecules$$

3.64 Ascorbic acid contains C, H, and O. In one combustion analysis, 5.24g of ascorbic acid yields 7.86g of CO_2 and 2.14g H_2O. Calculate the empirical formula and molecular formula of ascorbic acid given that its molar mass is about 176g/mol.

Need to know the moles of C, H, + O:

$$7.86g\ CO_2 \times \frac{1 mol\ CO_2}{44.01g\ CO_2} \times \frac{1 mol\ C}{1 mol\ CO_2} = 0.1786\ mol\ C \times \frac{12.01g\ C}{1 mol\ C} = 2.145g\ C$$

$$2.14g\ H_2O \times \frac{1 mol}{18.02g\ H_2O} \times \frac{2\ mol\ H}{1\ mol\ H_2O} = 0.2375\ mol\ H \times \frac{1.008g\ H}{1 mol\ H} = 0.2394g\ H$$

$$5.24g\ sample - (2.145g\ C + 0.2394g\ H) = 2.856g\ O \times \frac{1 mol\ O}{16.00g} = 0.1785\ mol\ O$$

$$C_{\frac{0.1786}{0.1785}} H_{\frac{0.2375}{0.1785}} O_{\frac{0.1785}{0.1785}} = C_1 H_{1.33} O_1$$ multiply by 3 to get whole Numbers

Empirical Formula = $C_3H_4O_3$

Empirical Formula weight = 88.06g

$$\frac{176g}{88.06} = 1.998 \approx 2$$

molecular formula = $C_6H_8O_6$

3.138 One of the reactions that occurs in a blast furnace, where iron ore is converted to cast iron, is:

$$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$$

Suppose that 1.64×10^3 kg of Fe is obtained from a 2.62×10^3 kg sample of Fe_2O_3. Assuming the reaction goes to completion, what is the percent purity of Fe_2O_3 in the original sample?

The percent yield will be equal to the percent purity of iron III

$$2.62 \times 10^3 kg\ Fe_2O_3 \times \frac{1000g\ Fe_2O_3}{1 kg\ Fe_2O_3} \times \frac{1 mol\ Fe_2O_3}{159.7g\ Fe_2O_3} \times \frac{2 mol\ Fe}{1 mol\ Fe_2O_3} \times \frac{55.85g\ Fe}{1 mol\ Fe} \times \frac{1 kg\ Fe}{1000g\ Fe}$$

$$= 1.83 \times 10^3\ kg\ Fe$$

$$\text{percent yield} = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100 = \frac{1.64 \times 10^3 kg\ Fe}{1.833 \times 10^3 kg\ Fe} \times 100 = 89.5\%$$

= purity of Fe_2O_3

3.94 When heated, lithium (Li) reacts with nitrogen (N_2) to form lithium nitride. What is the theoretical yield of lithium nitride in grams when 12.3g of Li is heated with 33.6g of N_2? If the actual yield of lithium nitride is 5.89g, what is the percent yield of the reaction?

① WRITE a balanced equation: $6Li(s) + N_2(g) \longrightarrow 2Li_3N(s)$

$$12.3g\ Li \times \frac{1\ mol\ Li}{6.941g\ Li} = 1.772\ mol\ Li$$

$$33.6g\ N_2 \times \frac{1\ mol\ N_2}{28.02g\ N_2} = 1.199\ mol\ N_2$$

$$1.199\ mol\ N_2 \times \frac{6\ mol\ Li\ needed}{1\ mol\ N_2} = 7.194\ mol\ Li\ needed$$ (Since we don't HAVE this much Li is limiting)

$$1.772\ mol\ Li \times \frac{2\ mol\ Li_3N}{6\ mol\ Li} \times \frac{34.83g\ Li_3N}{1\ mol\ Li_3N} = 20.6g\ Li_3N$$
= theoretical yield

Since Actual yield = 5.89g $\Rightarrow \frac{5.89g}{20.6g} \times 100 = 28.6\%$

3.90 Given the reaction:

$CaF_2 + H_2SO_4 \rightarrow$ Calcium sulfate and hydrofluoric acid

Write a balanced equation. In one process, 6.00 kg of CaF_2 is treated with an excess of sulfuric acid and yields 2.86kg of hydrofluoric acid. Calculate the percent yield of hydrofluoric acid.

$$CaF_2 + H_2SO_4 \longrightarrow CaSO_4 + 2HF$$

$$6.00 \times 10^3 g\ CaF_2 \times \frac{1\ mol\ CaF_2}{78.08g\ CaF_2} \times \frac{2\ mol\ HF}{1\ mol\ CaF_2} \times \frac{20.008g\ HF}{1\ mol\ HF} \times \frac{1\ kg}{1000g} = 3.075 kg\ HF$$

Since Actual yield is 2.86 kg HF:

$$\frac{2.86\ kg}{3.075\ kg} \times 100\% = 93.0\%$$

1. Fill in the correct formula for each compound on the line next to its name below:

Uranium (VI) fluoride UF_6

Magnesium hydroxide $Mg(OH)_2$

Sodium carbonate Na_2CO_3

Potassium sulfite K_2SO_3

Phosphoric Acid H_3PO_4

2. Fill in the correct name for each compound on the line next to its formula below:

$Fe(OH)_3$ iRON (III) Hydroxide

$Ca(OCl)_2$ Calcium hypochlorite

NH_4Cl ammonium chloride

$K_2Cr_2O_7$ potassium dichromate

KH_2PO_4 potassium dihydrogen phosphate

2.84 Fill in the correct formula for each compound on the line next to its name below:

Copper (I) cyanide $CuCN$

Strontium chlorite $Sr(ClO_2)_2$

Perbromic acid $HBrO_4$

Hydroiodic acid HI

Disodium ammonium phosphate $Na_2(NH_4)PO_4$

Potassium dihydrogen phosphate KH_2PO_4

Iodine heptafluoride IF_7

Tetraphosphorous decasulfide P_4S_{10}

Mercury (II) oxide HgO

Colbalt (II) carbonate $CoCO_3$

Selenium hexafluoride SeF_6

nickel (II) nitrate hexahydrate $Ni(NO_3)_2 \cdot 6H_2O$

2.82. Fill in the correct name for each compound on the line next to its formula below:

KClO	potassium hypochlorite
Ag_2CO_3	Silver Carbonate
HNO_2	nitrous Acid
$KMnO_4$	potassium permanganate
$CsClO_3$	Cesium chlorate
KNH_4SO_4	potassium Ammonium Sulfate
FeO	iRON (II) oxide
Fe_2O_3	iRON (III) oxide
$TiCl_4$	titanium (IV) chloride
NaH	Sodium hydride
Li_3N	lithium nitride
Na_2O	Sodium oxide
Na_2O_2	Sodium peroxide

2.96 What is wrong with the name given for each of the compounds below?

Ba Cl_2	Barium dichloride	ionic Compound - therefore No prefixes
Fe_2O_3	iron (II)oxide	IRON has +3 charge - therefore iron(III)oxide
$CsNO_2$	cesium nitrate	NO_2^- is nitrite ion — therefore cesium nitrite
$Mg(HCO_3)_2$	magnesium (II) bicarbonate	

(Not Needed since Mg ion is always Mg^{+2} since Magnesium is in second group of periodic TABLE; Alkaline Earth metal.