"I could've married hydrogen. I could've married oxygen. But NOOOOO ... I went and married one of the inert gases."

GENERAL STOICHIOMETRY PROBLEMS

28. Ammonia is used throughout the world as a fertilizer and in making nitrogenous plastics and fibers. It is usually manufactured in the Haber process, the direct reaction of N_2 with H_2 in the presence of other compounds that accelerate the reaction.

$$N_2(g) + 3 H_2(g) \longrightarrow 2 NH_3(g)$$
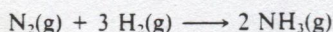
If you use 280. g of N_2, how many grams of H_2 are required for complete reaction? How many grams of NH_3 can be produced?

29. Silver bromide is an important component of photographic film. It can be made by the reaction

$$AgNO_3(aq) + NaBr(aq) \longrightarrow AgBr(s) + NaNO_3(aq)$$

If you have 2.6 g of sodium bromide, how many grams of silver nitrate are required for complete reaction? What is the maximum number of grams of sodium nitrate and of silver bromide that you could obtain?

30. Laughing gas, N_2O, is made by the careful thermal decomposition of ammonium nitrate.

$$NH_4NO_3(s) \longrightarrow N_2O(g) + 2 H_2O(g)$$
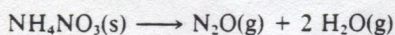
If you begin with 1.00×10^3 g (about 2 pounds) of ammonium nitrate, how many grams of laughing gas can you obtain? How many grams of water?

. When aluminum metal reacts with liquid bromine (Figure 4.3), the reaction produces aluminum bromide.

$$2 Al(s) + 3 Br_2(\ell) \longrightarrow Al_2Br_6(s)$$
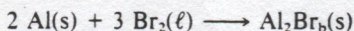
If you begin with 2.56 g of Al, how many grams of bromine are required for complete reaction? How many grams of aluminum bromide will be produced?

32. Ammonia can be made by treating calcium cyanamide with water.

$$CaCN_2(s) + 3 H_2O(\ell) \longrightarrow CaCO_3(s) + 2 NH_3(g)$$

How many grams of water would be required to react with $CaCN_2$ to produce 68.0 g of NH_3? How many grams of $CaCN_2$ are used in the process?

33. The very stable compound SF_6 is made by burning sulfur in an atmosphere of fluorine.

$$S_8(s) + 24 F_2(g) \longrightarrow 8 SF_6(g)$$
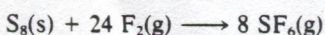
If you need 365 grams of SF_6, how many grams of sulfur, S_8, and how many grams of F_2 are required?

34. Iron can react with the oxygen in hot, dry air to produce Fe_3O_4. If 12.58 g of iron react with O_2 to give this oxide, how many grams of O_2 are required? How many grams of Fe_3O_4 are expected?

35. Aluminum metal can react with the oxygen in air to give aluminum oxide. If 0.569 g of aluminum is used, how many grams of aluminum oxide are produced? How many grams of oxygen gas are required for complete reaction?

36. The final step in the manufacture of pure platinum (for use in automobile catalytic converters and other purposes) is the reaction

$$3 (NH_4)_2PtCl_6(s) \longrightarrow$$
$$3 Pt(s) + 2 NH_4Cl(g) + 2 N_2(g) + 16 HCl(g)$$
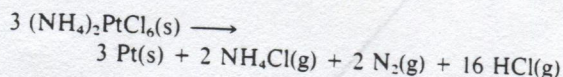
If you heat 34.6 g of $(NH_4)_2PtCl_6$, how many grams of Pt metal should you isolate? How many grams of HCl should you expect?

37. Passing an electrical current into brine, a solution of sodium chloride in water, gives hydrogen gas, chlorine gas, and sodium hydroxide according to the equation

$$2 NaCl(aq) + 2 H_2O(\ell) \longrightarrow$$
$$H_2(g) + Cl_2(g) + 2 NaOH(aq)$$
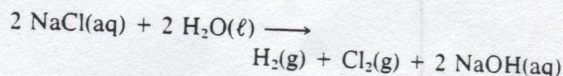
This important commercial process is the source of much of the chlorine and sodium hydroxide used in our economy. Assume you have 2550 g of NaCl in solution. Calculate the mass of each of the products expected from the reaction above.

38. The overall equation for the reduction of iron ore to iron metal in a blast furnace is

$$Fe_2O_3(s) + 3 CO(g) \longrightarrow 2 Fe(s) + 3 CO_2(g)$$

(a) How many grams of CO are required to consume completely 365 g of Fe_2O_3?

(b) How many kilograms of Fe_2O_3 are required to produce 27.9 kg of Fe?

39. Hydrofluoric acid, HF, is never sold in glass bottles, because glass is composed of calcium and sodium silicates that react with HF. The reaction can be depicted, for simplicity, as the interaction of silicon dioxide and the acid.

$$SiO_2(s) + 4 HF(aq) \longrightarrow SiF_4(g) + 2 H_2O(\ell)$$

(a) How many grams of HF would you need to react completely with 256 g of SiO_2?

(b) How many grams of SiF_4 would be produced from 300. g of pure silica, SiO_2? (Assume more HF is present than is required.)

40. Oil paintings in which "white lead" has been used can be blackened by reaction with H_2S from air pollution or from the glaze over the painting itself. The blackening comes from the formation of lead sulfide, which may be cleaned off by washing with hydrogen peroxide, H_2O_2. The reaction for the cleaning process is

$$PbS(\text{black solid}) + 4 H_2O_2(aq) \longrightarrow$$
$$PbSO_4(s) + 4 H_2O(\ell)$$
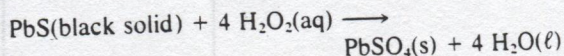
(a) How many grams of H_2O_2 must be used to clean off 0.24 g of PbS?

(b) If 0.072 g of H_2O form in the reaction, how many grams of $PbSO_4$ must also have been formed?

41. White phosphorus, P_4, is made by heating calcium phosphate with silica and carbon.

$$2 Ca_3(PO_4)_2(s) + 6 SiO_2(s) + 10 C(s) \longrightarrow$$
$$6 CaSiO_3(s) + 10 CO(g) + P_4(s)$$
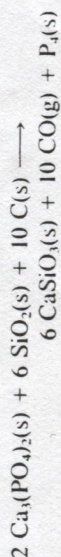
If you have 1.00 pound (454 g) of calcium phosphate, how many grams each of SiO_2 and C must be used for complete reaction? How many grams of P_4 should