Limiting Reactants, Theoretical and Percentage Yields Key

1. $4\ PCl_5 + 2\ H_2O \longrightarrow 4\ HCl + 2\ O_2$

If a reaction mixture contains 0.25 mol PCl_5 and 0.10 mol H_2O, what is the limiting reactant? How many moles of oxygen can be produced?

$$0.25\ mol\ PCl_5 \times \frac{2\ mol\ O_2}{4\ mol\ PCl_5} = 0.13\ mol\ O_2$$

$$0.10\ mol\ H_2O \times \frac{2\ mol\ O_2}{2\ mol\ H_2O} = 0.10\ mol\ O_2$$

Limiting reactant: H_2O Maximum or theoretical yield = 0.10 mol O_2

2. $NaCl + H_2SO_4 \longrightarrow NaHSO_4 + HCl$

If a reaction mixture contains 10.0 g of sodium chloride and 12.0 g of sulfuric acid, what is the limiting reactant? What is the theoretical yield of hydrochloric acid? How many grams of excess reactant are left unconsumed?

$2\ NaCl + H_2SO_4 \rightarrow 2\ HCl + Na_2SO_4$

$$10.0\ g\ NaCl \times \frac{1\ mol\ NaCl}{58.44\ g\ NaCl} \times \frac{2\ mol\ HCl}{2\ mol\ NaCl} \times \frac{36.46\ g\ HCl}{1\ mol\ HCl} = 6.24\ g\ HCl$$

$$12.0\ g\ H_2SO_4 \times \frac{1\ mol\ H_2SO_4}{98.08\ g\ H_2SO_4} \times \frac{2\ mol\ HCl}{1\ mol\ H_2SO_4} \times \frac{36.46\ g\ HCl}{1\ mol\ HCl} = 8.92\ g\ HCl$$

Limiting reactant: NaCl Maximum or theoretical yield = 6.24 g HCl

$$10.0\ g\ NaCl \times \frac{1\ mol\ NaCl}{58.44\ g\ NaCl} \times \frac{1\ mol\ H_2SO_4}{2\ mol\ NaCl} \times \frac{98.08\ g\ H_2SO_4}{1\ mol\ H_2SO_4} = 8.38\ g\ H_2SO_4$$ required to consume all of the NaCl (Limiting reactant)

12.0 g H_2SO_4 – 8.38 g H_2SO_4 = 3.62 g of excess H_2SO_4 remains after reaction is complete