Example Of Limiting Reactant Problems Without Work

25.8 grams of oxygen gas are added to 65.4 grams of hydrogen chloride gas in the following reaction:

$4\ HCl_{(g)} + 1\ O_{2\,(g)} \rightarrow 2\ Cl_{2\,(g)} + 2\ H_2O_{1\,(g)}$

a. Determine the limiting reactant
b. Determine the mass (in g) of each of the products that are formed in the reaction.
c. Determine the excess reactant and how many grams are left after the reaction.

Step 2 $mm\ O_2 = 2(16g) = \frac{32g\ O_2}{1\ m.u.\ O_2}$ $mm\ H_1Cl_1 = 1(1g) + (35.5g) = \frac{36.5g\ HCl}{1\ m.u.\ HCl}$

$= \frac{37g\ HCl}{1\ m.u.\ HCl}$

O_2: $25.8g\left(\frac{1\ m.u.\ O_2}{32g\ O_2}\right) = 0.8062\ m.u.\ O_2$

HCl: $65.4g\ HCl\left(\frac{1\ m.u.\ HCl}{37g\ HCl}\right) = 1.767\ m.u.\ HCl$

Assume: HCl goes to completion: $(1.767\ m.u.\ HCl)\left(\frac{1\ m.u.\ O_2}{4\ m.u.\ HCl}\right) = 0.4417\ m.u.\ O_2$ needed to react all HCl

Since we need $0.4417\ m.u.\ O_2$ to completely react all HCl and we have $0.8062\ m.u.$, $\therefore$ HCl is limiting reactant

$mm\ Cl_2 = 2(35.5g) = \frac{71g\ Cl_2}{1\ m.u.\ Cl_2}$

$\therefore (1.7675\ m.u.\ HCl)\left(\frac{2\ m.u.\ Cl_2}{4\ m.u.\ HCl}\right)\left(\frac{71g\ Cl_2}{1\ m.u.\ Cl_2}\right) = 62.74g\ Cl_2 = \boxed{62.7g\ Cl_2}$

$(1.7675\ m.u.\ HCl)\left(\frac{2\ m.u.\ H_2O}{4\ m.u.\ HCl}\right)\left(\frac{18g\ H_2O}{1\ m.u.\ H_2O}\right) = \frac{15.90g\ H_2O}{\boxed{15.9g\ H_2O}}$

$mm\ H_2O = 2(1g) + 1(16g) = \frac{18g\ H_2O}{1\ m.u.\ H_2O}$

$\therefore$ Initial − Reacted = left over (O_2 is in excess)

O_2 reacted: $(1.7675\ m.u.\ HCl)\left(\frac{1\ m.u.\ O_2}{4\ m.u.\ HCl}\right) = 0.4418\ m.u.\ O_2$ reacted

$0.8062\ m.u.\ O_{2\ initial} - 0.4418\ m.u.\ O_{2\ reacted} = 0.3644\ m.u.\ O_2$ left over

$(0.3644\ m.u.\ O_2)\left(\frac{32g\ O_2}{1\ m.u.\ O_2}\right) = 11.66g\ O_2 \rightarrow \boxed{11.7g\ O_2 \text{ left over}}$