Limiting Reactants

Limiting Reactant (LR) - reactant this is used up 1^{st} in a reaction, controls amount of product made

Excess Reactant (ER) - all the other reactants

Actual Yield (AY) - amount of product produced in reality

Theoretical Yield (TY) - amount of product stoichiometry says we should produce

$$\boxed{\%\text{ yield} = \frac{AY}{TY} \times 100}$$

Given 1 HF Given 2 $MgCl_2$

Ex) 15.0g of hydrofluoric acid reacts with 30.0g of magnesium chloride in the reaction below. Determine the ~~LR~~, ~~ER~~, the ~~TY~~ of hydrochloric acid and if 18.0g of hydrochloric acid are actually produced, find the %yield HCl AY

$$2\,HF + \_\,MgCl_2 \rightarrow 2\,HCl + MgF_2$$

15.0g 30.0g ?

$$15.0\,\cancel{g\,HF}\left(\frac{1\,\cancel{mol\,HF}}{20.01\,\cancel{g\,HF}}\right)\left(\frac{2\,mol\,HCl}{2\,\cancel{mol\,HF}}\right) = .750\text{ mol HCl}$$

1.01g
+19.00g
20.01g

TY

$$30.0\,\cancel{g\,MgCl_2}\left(\frac{1\,\cancel{mol\,MgCl_2}}{95.21\,\cancel{g\,MgCl_2}}\right)\left(\frac{2\,mol\,HCl}{1\,\cancel{mol\,MgCl_2}}\right) = .630\,\cancel{mol\,HCl}\left(\frac{36.46\,g\,HCl}{1\,\cancel{mol\,HCl}}\right)$$

smallest amount

24.31
+70.90
95.21

1.01
+35.45
36.46

$\boxed{TY = 23.0g\,HCl}$

$\boxed{\begin{array}{l} LR = MgCl_2 \\ ER = HF \end{array}}$

$$\%\text{ Yield} = \frac{18.0g}{23.0g} \times 100 = \boxed{78.3\%}$$

Ex) 100.g of sodium (Na) reacts with 70.0g of aluminum oxide (Al_2O_3) in the reaction below. Determine the (1) LR, (2) ER, and the (3) TY of sodium oxide. If 75.0g of sodium oxide is produced in lab, find the (4) %yield.

$$6\,Na + Al_2O_3 \rightarrow 2\,Al + 3\,Na_2O$$

100.g (Given 1) | 70.0g (Given 2) | ?

$$100.\,\cancel{g\,Na}\left(\frac{1\,\cancel{mol\,Na}}{22.99\,\cancel{g\,Na}}\right)\left(\frac{3\,mol\,Na_2O}{6\,\cancel{mol\,Na}}\right) = 2.17\ mol\ Na_2O$$

(3) TY

$$70.0\,\cancel{g\,Al_2O_3}\left(\frac{1\,\cancel{mol\,Al_2O_3}}{101.96\,\cancel{g\,Al_2O_3}}\right)\left(\frac{3\,mol\,Na_2O}{1\,\cancel{mol\,Al_2O_3}}\right) = \underbrace{2.06\,\cancel{mol\,Na_2O}}_{\text{smaller}}\left(\frac{61.98\,g\,Na_2O}{1\,\cancel{mol\,Na_2O}}\right)$$

(1) LR = Al_2O_3

(2) ER = Na

(3) TY = 128 g Na_2O

(4) $\%\text{yield} = \dfrac{AY}{TY} \times 100$

$$= \frac{75.0\,g}{128} \times 100 = \boxed{58.6\%}$$