Percent Yields from Reactions

- **Theoretical yield** is calculated by assuming that the reaction goes to completion.
- **Actual yield** is the amount of a specified pure product made in a given reaction.
  - In the laboratory, this is the amount of product that is formed in your beaker, after it is purified and dried.
- **Percent yield** indicates how much of the product is obtained from a reaction.

$$\text{percent yield} = \frac{\text{actual yield of product}}{\text{theoretical yield of product}} \times 100\%$$

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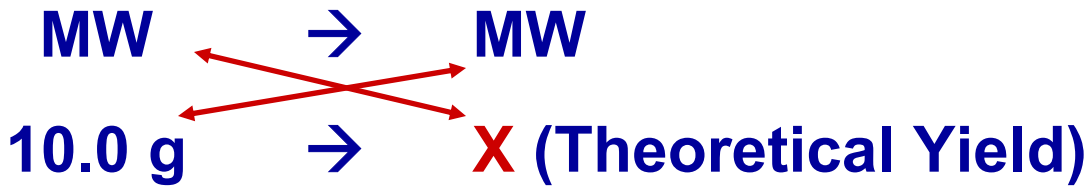
Percent Yields from Reactions

A 10.0 g sample of ethanol, C_2H_5OH, was boiled with excess acetic acid, CH_3COOH, to produce 14.8 g of ethyl acetate, $CH_3COOC_2H_5$. What is the percent yield?

$CH_3COOH + C_2H_5OH \rightarrow CH_3COOC_2H_5 + H_2O$



Percent Yields from Reactions

$$CH_3COOH + C_2H_5OH \rightarrow CH_3COOC_2H_5 + H_2O$$

1. Calculate the theoretical yield

$$?\ g\ CH_3COOC_2H_5 = 10.0\ g\ C_2H_5OH \times \frac{88.0\ g\ CH_3COOC_2H_5}{46.0\ g\ C_2H_5OH}$$

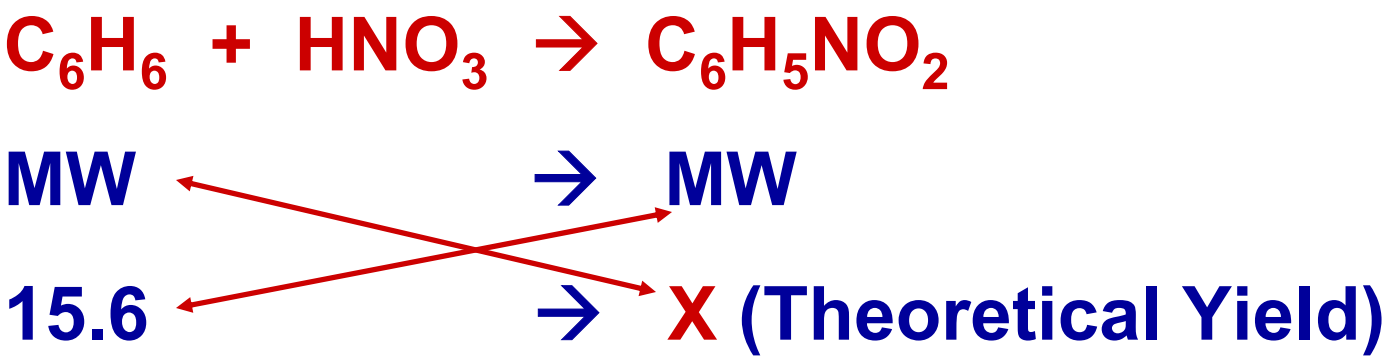
$$= 19.1\ g\ CH_3COOC_2H_5$$

2. Calculate the percent yield.

$$\%\ \text{yield} = \frac{14.8\ g\ CH_3COOC_2H_5}{19.1\ g\ CH_3COOC_2H_5} \times 100\% = 77.5\%$$

Percent Yields from Reactions

- Example 3-11, **P.100**. A 15.6-g sample of C_6H_6 is mixed with excess HNO_3. We isolate 18.0 g of $C_6H_5NO_2$. What is the percent yield of $C_6H_5NO_2$ in this reaction?



Percent Yields from Reactions

$$X = \frac{15.6 \times 123.1 \text{ g } C_6H_5NO_2}{78.1 \text{ g } C_6H_6}$$

X (Theoretical Yield) = 24.6 g $C_6H_5NO_2$

$$\text{Percent Yield} = \frac{\text{actual Yield (18.9 g)}}{\text{Theoretical Yield (24.6 g)}} \times 100 = 73.2\ \%$$

Percent Yields from Reactions

- Salicylic acid reacts with acetic anhydride to form aspirin, acetylsalicylic acid. If the percent yield in this reaction is 78.5%, what mass of salicylic acid is required to produce 150. g aspirin?

- **$2\ C_7H_6O_3 + C_4H_6O_3 \rightarrow 2\ C_9H_8O_4 + H2O$**

  salicylic acid acetic anhydride aspirin

Percent Yields from Reactions

$$78.5 = \frac{\text{actual Yield (150 g)}}{\text{Theoretical Yield (g)}} \times 100$$

$2\ C_7H_6O_3 + C_4H_6O_3 \rightarrow 2\ C_9H_8O_4 + H_2O$

salicylic acid — acetic anhydride — aspirin

2MW → 2MW

X → 191.08 (Theoretical Yield)

ANSWER: X = 146 g