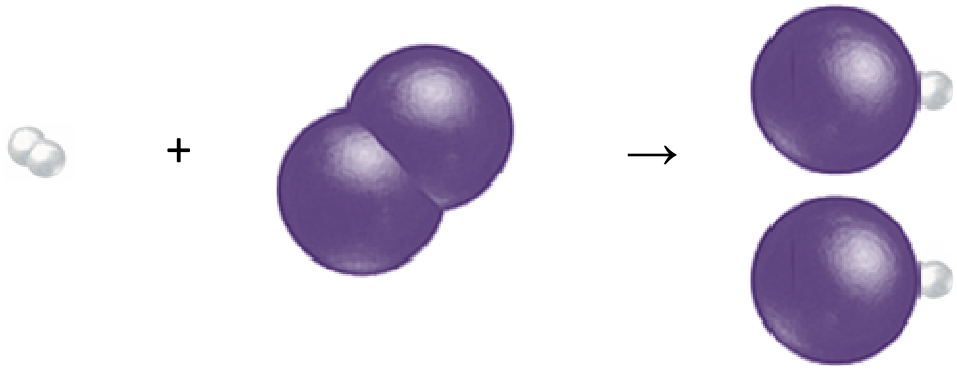
**Stoichiometry**: study of mass and amounts in chemical reactions

What masses of $H_2$ and $I_2$ are required to make 10.0 g HI?

(1) $H_2$ + (1) $I_2$ → 2 HI



1 $H_2$ molecule + 1 $I_2$ molecule → 2 HI molecules

1 dozen $H_2$ molecules + 1 dozen $I_2$ molecules → 2 dozen HI molecules

1 mol $H_2$ + 1 mol $I_2$ → 2 mol HI

A **mole ratio** can be created with coefficients in balanced chemical equation

$$\frac{1 \text{ mol } I_2}{1 \text{ mol } H_2} \qquad \frac{2 \text{ mol HI}}{1 \text{ mol } I_2} \qquad \text{etc.}$$

Mole ratios

$(1)H_2 + (1)I_2 \rightarrow 2\,HI$

In the balanced chemical equation on the previous page, how many moles $H_2$ are required to form 5.3 mol HI?

$$5.3 \text{ mol HI} \times \frac{1 \text{ mol } H_2}{2 \text{ mol HI}} =$$

mol ratio

#'s from balancing coefficients

$(1)Cu + 2\,AgNO_3 \rightarrow 2\,Ag + Cu(NO_3)_2$

If 2.3 mol Cu react, how many mol $AgNO_3$ will react?

$$2.3 \text{ mol Cu} \times \frac{2 \text{ mol } AgNO_3}{1 \text{ mol Cu}} = 4.6 \text{ mol } AgNO_3$$

How many grams $H_2$ are required to form 10.0 g HI?

$H_2 + I_2 \rightarrow 2\,HI$

? g $H_2$ —(molar mass)→ mol $H_2$ ←(mol ratio, from coeff.)— mol HI ←(molar mass)— 10.0 g HI

mole ratio only Conversion that changes the chemical formula.

g → mol → mol → g

$$10.0 \text{ g HI} \times \frac{1 \text{ mol HI}}{127.908 \text{ g HI}} \times \frac{1 \text{ mol } H_2}{2 \text{ mol HI}} \times \frac{2.016 \text{ g } H_2}{1 \text{ mol } H_2} =$$

molar mass always per 1 mol

**0.0788 g $H_2$**

Stoichiometry problems

$2\ C_8H_{18} + 25\ O_2 \rightarrow 16\ CO_2 + 18\ H_2O$

(oct.)

How many grams $CO_2$ are produced from combustion of 100. g octane ($C_8H_{18}$)?

$$100.\ g\ oct \times \frac{1\ mol\ oct}{114.224\ g\ oct} \times \frac{16\ mol\ CO_2}{2\ mol\ oct} \times \frac{44.01\ g\ CO_2}{1\ mol\ CO_2}$$

$$= \boxed{308\ g\ CO_2}$$

How many grams $CO_2$ are produced from combustion of 100. g propane, $C_3H_8$?

$C_3H_8 + 5O_2 \longrightarrow 3CO_2 + 4H_2O$

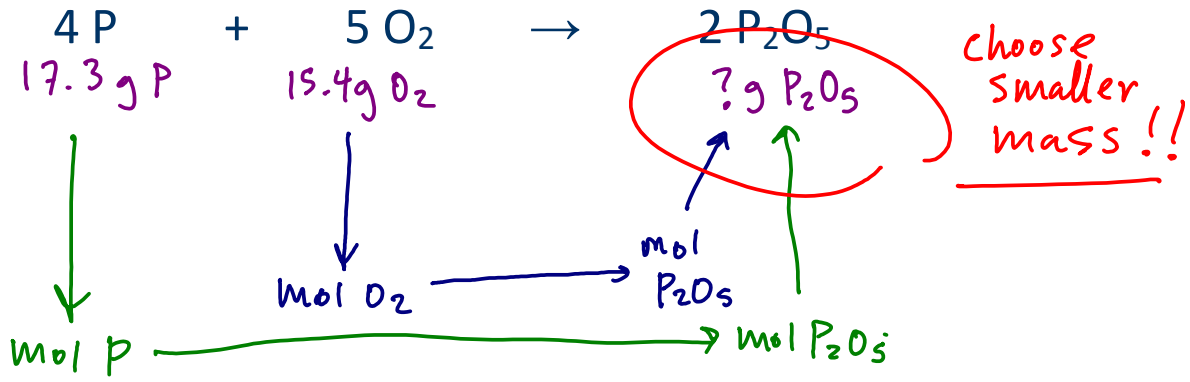
$$100.\ g\ C_3H_8 \times \frac{mol\ C_3H_8}{g\ C_3H_8} \times \frac{mol\ CO_2}{mol\ C_3H_8} \times \frac{g\ CO_2}{mol\ CO_2} = \boxed{299\ g\ CO_2}$$

There is **no direct route** from mass to mass. (Use the mol ratio in the middle of a g → mol → mol → g calculation)

Only use the coefficients in the mol ratio, **not** in molar masses!

What if you're given masses of two reactants and are asked for product mass?

17.3 g P are reacted with 15.4 g $O_2$. How many grams $P_2O_5$ can be produced?




This is a **limiting reactant** problem:

- One reactant is consumed before the other
- Once one reactant is consumed, the reaction stops!
- The reactant that's consumed first is the limiting reactant