Stoichiometry

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* Whether you are making omelettes in a kitchen or soap in a factory, you need to know the quantities of ingredients required to produce a certain quantity of product.

* For example, a manufacturing company needs to know how much raw material to buy to make the quantities of products ordered by its customers.

* **When baking 32 chocolate chip cookies (one for every person in the class) you need to know how MUCH of each ingredient to add in.**

What is stoichiometry?

* **Stoichiometry:** the study of the quantitative relationships among amounts of products used and amounts of products formed in chemical reactions.

Steps in Stoichiometric Calculation

* Start: Read the question carefully

* Step 1: Write the unbalanced chemical equation

* Step 2: Balance the equation, list given values, and molar masses.

* Step 3: Convert mass of given substance to moles of given substance.

Steps in Stoichiometric Calculation

* Step 4: Convert amount of given substance to amount of required substance.

    * Use mole ratio from balanced chemical equation.

* Step 5: Convert amount of required substance to required values.

    * Required value may be mass or number of particles.

Example

* Propane, C_3H_8, is a gas that is commonly used in barbecues. Calculate the mass of oxygen that is needed to burn 15g of propane.
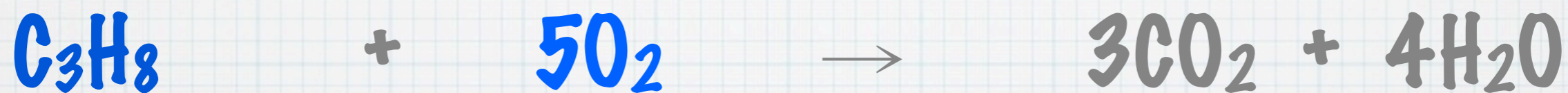
Step 1

* Write unbalanced equation

* $C_3H_8 + O_2 \longrightarrow CO_2 + H_2O$
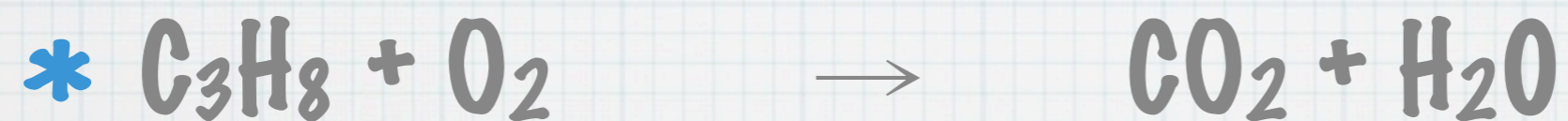
Step 2

* Balance equation, list given values and molar masses

C_3H_8 + $5O_2$ → $3CO_2$ + $4H_2O$

m= 15 g   m= ?
M= 44.11 g/mol   M= 32.00 g/mol

Step 3

* **Convert mass of given substances to amount of given substance**

$$n_{C_3H_8} = \frac{m}{M}$$

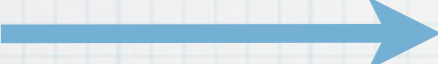$$n_{C_3H_8} = \frac{15g}{44.11g/mol}$$

$$= 0.34 \text{ mol } C_3H_8$$

Step 4

* Convert amount of given substance to amount of required substance

$$\frac{\text{Ratio of Given}}{\text{Ratio of Required}} = \frac{n_{given}}{n_{required}}$$

Step 4

* **Convert amount of given substance to amount of required substance**

Formula $\longrightarrow$ $\dfrac{\text{Ratio of } C_3H_8}{\text{Ratio of } O_2}$ $=$ $\dfrac{n_{C_3H_8}}{n_{O_2}}$

Step 4

* Convert amount of given substance to amount of required substance

Formula → $\dfrac{\text{Ratio of } C_3H_8}{\text{Ratio of } O_2} = \dfrac{n_{C_3H_8}}{n_{O_2}}$

Substitute in values → $\dfrac{1}{5} = \dfrac{0.34\text{mol}}{n_{O_2}}$

Cross multiply and solve → $n_{O_2} = 1.7 \text{ mol}$

Step 5

* Convert amount of required substance to required value

  * Given: $n_{O_2} = 1.7$ mol O_2

  * Given: $M_{O_2} = 32.00$ g/mol

$$m_{O_2} = n \times M$$

$$= 32.00 \times 1.7$$

$$= 54g\ O_2$$

Therefore 54 grams of O2 is required to completely combust 15 g of propane.

Summary

$$C_3H_8 \quad + \quad 5O_2 \quad \rightarrow \quad 3CO_2 + 4H_2O$$

Converted from mass to moles

Converted from moles to mass

Molar Ratio

Homework

* p 304 # 21-23