Further Application of the Ideal-Gas Equation (Stoichiometry)

Advanced Chemistry

Introduction

°C + 273.15

atm L mol K

- Ideal Gas Law: PV = nRT, where R = 0.08206 L-atm/mol-K
- In this section, we will connect the ideal gas law to the concept of the stoichiometry

Using Ideal Gas Law & Stoichiometry

- We can use both ideal gas law & stoichiometry to find values for compounds.
- If given moles/grams: Start stoic
  - Use mole ratio to determine moles of the other compound
  - From there, use ideal-gas law & information in problem to determine what you are trying to find
- If not given moles/grams: Start ideal
  - Use information from the problem and ideal-gas law to determine moles of one compound
  - Then determine what you are trying to find and use stoichiometry to get there.

Example

- If an air bag has a volume of 36.0 L and is to be filled with nitrogen gas at 1.15 atm and 26.0°C, how many grams of NaN3, must be decomposed?

N_2

$2NaN_3(s) \rightarrow 2\ Na(s) + 3N_2(g)$

N_2

$P = 1.15\ atm$
$V = 36L$
$n = x$
$R = .08206$
$T = 299.15$

$$(1.15)(36) = (x)(.08206)(299.15)$$

$$\frac{41.4 = 24.548249x}{24.548249}$$

$$x = 1.686474665\ mol\ N_2$$

$$1.686474665\ mol\ N_2 \times \frac{2\ mol\ NaN_3}{3\ mol\ N_2} \times \frac{65.011g\ NaN3}{1\ mol\ NaN_3} = 73.1g\ NaN3$$

More Practice

- How many grams of CaH_2 are needed to generate 145.0 L of H_2 gas if the pressure of H_2 is 825.0 torr at 21.00°C?

$$CaH_2(s) + 2H_2O(l) \rightarrow Ca(OH)_2(aq) + 2H_2(g)$$

Example

- Calculate the volume of dry CO_2 produced at body temperature (37.0 ºC) and 0.970 atm when 24.5 g of glucose is consumed in the reaction.

$$C_6H_{12}O_6(s) + 6O_2(g) \rightarrow 6CO_2(g) + 6H_2O(l)$$

$$24.5\text{g glucose} \times \frac{1\text{mol glucose}}{180.1548\text{g glucose}} \times \frac{6\text{ mol CO}_2}{1\text{ mol glucose}} = 0.815964936\text{8 mol CO}_2$$

$$(.970)(x) = (.815964936\text{8})(.08206)(310.15)$$

$$\frac{.97x = 20.76704935}{.97}$$

$$x = 21.4\text{ L CO}_2$$

More Practice

- How many liters of $NH_3(g)$ at 850.0ºC and 5.00 atm are required to react with 1.00 mol of $O_2(g)$ in this reaction?

$$4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(g)$$