Stoichiometry

$1\ CH_4 + 2\ O_2 \longrightarrow 1\ CO_2 + 2\ H_2O$

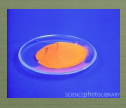
1 mole = 6.02×10^{23} of anything

Avogadro's number

Stoichiometry

How many grams of mercury are formed from 2.16 g HgO?

$2\ HgO_{(s)} \longrightarrow 2\ Hg_{(l)} + O_{2(g)}$



Stoichiometry

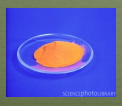
How many grams of mercury are formed from 2.16 g HgO? $2\ HgO_{(s)} \longrightarrow 2\ Hg_{(l)} + O_{2(g)}$

2.16 g HgO x 1mole/216.6g = 0.01 moles HgO

= 0.01 moles Hg

0.01 moles x 200.6

= 2.00 g Hg



Stoichiometry

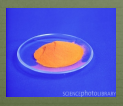
How many grams of mercury are formed from 2.16 g HgO? $2\ HgO_{(s)} \longrightarrow 2\ Hg_{(l)} + O_{2(g)}$

2.16 g 2.00 g 0.16 g

$$\frac{2 \text{ moles HgO}}{1 \text{ mole } O_2} \times 0.01 \text{ moles} =$$

0.005 moles O_2 x 32

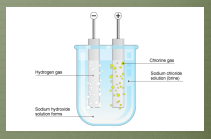
= 0.16 g O_2



Moles in Reactions

- How many grams of Cl_2 are made from the decomposition of 100 g NaCl?

$2\ NaCl \text{ ------> } 2\ Na + Cl_2$



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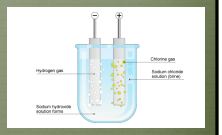

$100\ g\ NaCl \times \frac{1\ mole}{58.45\ g} = 1.71\ moles$

$1.71\ moles\ NaCl \times \frac{1\ mole\ Cl_2}{2\ moles\ NaCl} = 0.85\ moles\ Cl_2$

$0.85\ moles\ Cl_2 \times 70.9\ g/mole = 60.3\ g\ Cl_2$

Stoichiometry

- How many grams of sodium azide are needed to fill a car's air bag with 75 g N_2?

$2\ NaN_3 \text{ -----> } 3\ N_2 + 2\ Na$

Stoichiometry

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$2\ NaN_3 \text{ -----> } 3\ N_2 + 2\ Na$

$75\ g\ N_2 \times \frac{1\ mole}{28\ g} = 2.68\ moles$

$2.68\ moles\ N_2 \times \frac{2\ moles\ NaN_3}{3\ moles\ N_2} = 1.79\ moles\ NaN_3$

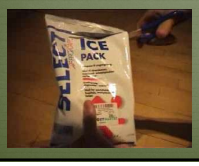
$1.79\ moles\ NaN_3 \times 65\ g/mole = 116\ g\ NaN_3$

Stoichiometry

- Ammonium nitrate can explode at high temperatures:

$NH_4NO_{3(s)} \rightarrow N_{2(g)} + O_{2(g)} + H_2O_{(g)}$

What is the total mass of gases produced when 100 g ammonium nitrate explodes?



Stoichiometry

- Ammonium nitrate can explode at high temperatures:

$2\ NH_4NO_{3(s)} \rightarrow 2\ N_{2(g)} + O_{2(g)} + 4\ H_2O_{(g)}$

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Stoichiometry

- Ammonium nitrate can explode at high temperatures:

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What is the total mass of gases produced when 100 g ammonium nitrate explodes?

100 g x 1 mole/80 g = 1.25 moles NH_4NO_3

1.25 moles NH_4NO_3 x 2 moles N_2/2 moles NH_4NO_3 = **1.25 moles N_2**

1.25 moles NH_4NO_3 x 1 mole O_2/2 moles NH_4NO_3 = **0.625 moles O_2**

1.25 moles NH_4NO_3 x 4 moles H_2O/2 moles NH_4NO_3 = 2.5 moles H_2O

Stoichiometry

- Ammonium nitrate can explode at high temperatures:

$2\ NH_4NO_{3(s)} \rightarrow 2\ N_{2(g)} + O_{2(g)} + 4\ H_2O_{(g)}$

What is the total mass of gases produced when 100 g ammonium nitrate explodes

1.25 moles N_2 x 28 g/mole = 35 g N_2

0.625 moles O_2 x 32 g/mole = 20 g O_2

2.5 moles H_2O x 18 g/mole = 45 g H_2O

100 g TOTAL

Stoichiometry

- Tungsten metal is used to make lightbulb filaments. How much tungsten (VI) oxide and hydrogen are needed to make 50 g tungsten?
  - $WO_{3(s)} + 3\ H_{2(g)} \text{ ----> } W_{(s)} + 3\ H_2O_{(g)}$

Stoichiometry

- Tungsten metal is used to make lightbulb filaments. How much tungsten (VI) oxide and hydrogen are needed to make 50 g tungsten?
  - $WO_{3(s)} + 3\ H_{2(g)} \text{ ----> } W_{(s)} + 3\ H_2O_{(g)}$

50 g x 1 mole/183.84 g = 0.272 moles W

0.272 mole WO_3 x 231.54 g/1 mole WO_3 = 63 g WO_3

0.816 moles x 2 g/1 mole H_2 = 1.63 g H_2

Limiting Reagents

- Tungsten metal is used to make lightbulb filaments. How much tungsten (VI) oxide and hydrogen are needed to make 50 g tungsten?
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What if only only 1 g of Hydrogen is available?

What if only 45 g of W are produced (when 50 g is expected)?

Yield

$$\text{Yield} = \frac{\text{actual amount}}{\text{expected amount}} \times 100\%$$

Yield

- Ammonium nitrate (NH_4NO_3) decomposes to form dinitrogen oxide (N_2O) gas and water. If 12.65 grams of N_2O are formed from 25 grams of NH_4NO_3, what is the yield?

NH_4NO_3 -----> N_2O + 2 H_2O

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NH_4NO_3 -----> N_2O + 2 H_2O

25 g NH_4NO_3 x 1 mole/80 g = 0.3125 moles NH_4NO_3

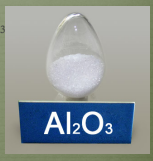
12.65 g N_2O x 1mole/44g = 0.2875 moles N_2O

$$\text{Yield} = \frac{\text{actual amount}}{\text{expected amount}} \times 100\% = \frac{0.2875 \text{ moles}}{0.3125 \text{ moles}} = 92\%$$

Yield

If 50 g of aluminum metal react in oxygen to generate a 75% yield of aluminum oxide, how many grams are produced?

4 Al + 3 O_2 ----------> 2 Al_2O_3



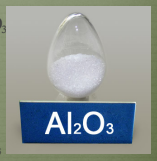
Yield

If 50 g of aluminum metal react in oxygen to generate a 75% yield of aluminum oxide, how many grams are produced?

4 Al + 3 O_2 ----------> 2 Al_2O_3

50 g Al x $\frac{1 mole}{27 g}$ = 1.85 moles Al

1.85 moles Al x $\frac{2 moles\ Al_2O_3}{4 moles\ Al}$ = 0.93 moles Al_2O_3



75% 0.93 moles = 0.694 moles Al_2O_3 x 102 g/mole = 70.83 g Al_2O_3

Limiting Reagent

- 50 hamburger patties + 120 buns = 50 burgers



Limiting Reagent

- **50 hamburger patties** + 120 buns = 50 burgers
  - *Limiting* *excess*

20 buns left over



Limiting Reagent

In the formation of tungsten, 3 moles of each reactant are available for the reaction. What substance is the excess reactant?

$WO_{3(s)} + 3\ H_{2(g)} \rightarrow W_{(s)} + 3\ H_2O_{(g)}$

Limiting Reagent

In the formation of tungsten, 3 moles of each reactant are available for the reaction. What substance is the excess reactant?

$WO_{3(s)} + 3\ H_{2(g)} \rightarrow W_{(s)} + 3\ H_2O_{(g)}$

3 mol of hydrogen are needed for the reaction of

1 mol of Tungsten so hydrogen is limiting

(W = excess)

Conservation of Energy

- Potential Energy + Kinetic Energy = **TOTAL ENERGY**

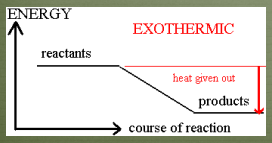
- **ENERGY** can be converted from one form to another but cannot be created or destroyed.

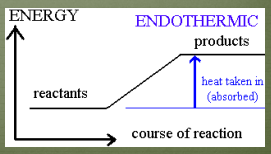
Enthalpy H

For $\Delta H = H_{products} - H_{reactants}$

If $\Delta H = +$ Endothermic

$\Delta H = -$ Exothermic





Reaction Energy

- When ethyl alcohol combusts, 1360 kJ of energy is released per mole of alcohol.
  - $C_2H_5OH + 3\,O_2$ ----------> $2\,CO_2 + 3\,H_2O$

How much energy is released when 250 mL ethyl alcohol combusts?

Reaction Energy

- When ethyl alcohol combusts, 1360 kJ of energy is released per mole of alcohol.
  - $C_2H_5OH + 3\,O_2$ ----------> $2\,CO_2 + 3\,H_2O$

How much energy is released when 250 mL ethyl alcohol combusts?

250 mL x 0.78 g/mL = 195 g ethyl alcohol

195 g x 1 mole/46 g = 4.24 moles

4.24 moles x 1360 kJ/mole = **5765 kJ released**

Unit 2 Review

- Balancing chemical equations
- Mass percent, empirical and molecular formulas
- Molecular mass and the mole
- Mole <–> gram conversions
- Reaction Stoichiometry; Yield; Limiting Reagent
- Energy of Reaction