

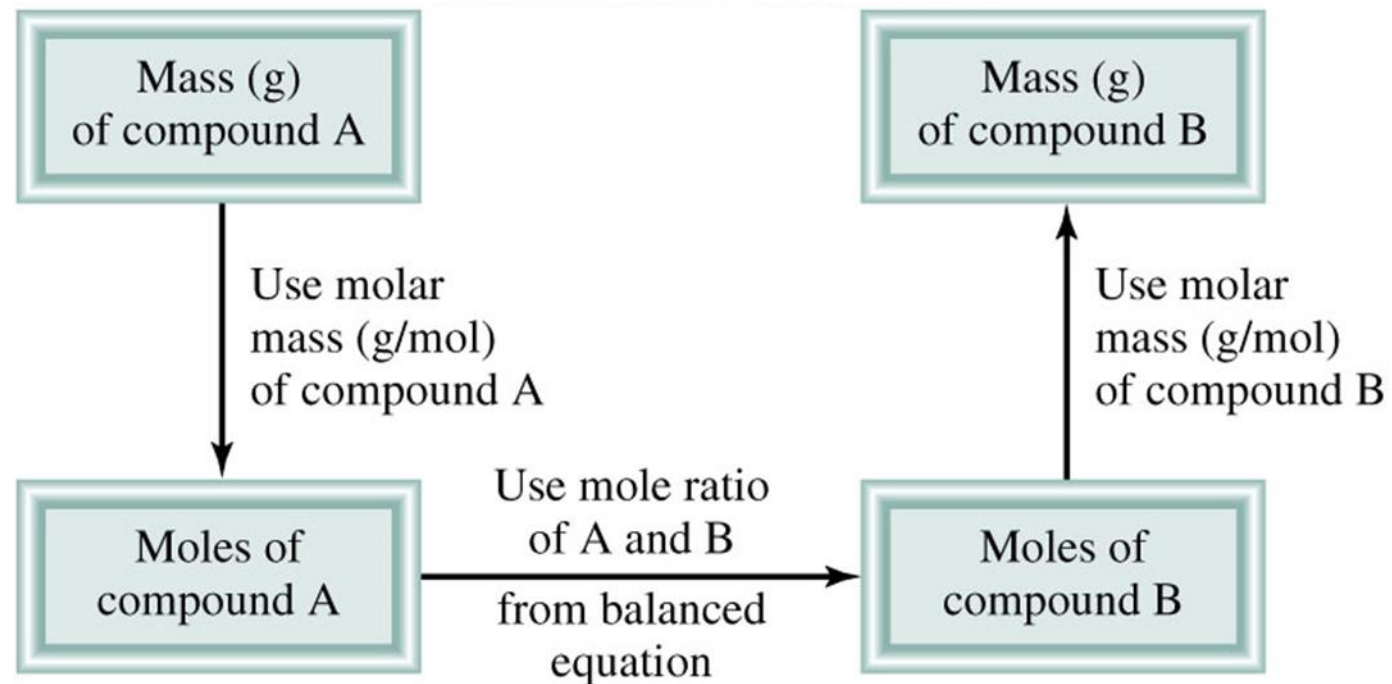
Chapter 3: Mass Relationships in Chemical Reactions Part 2

Dr. Dalal Alezi
dalezi@kau.edu.sa

14/10/2018

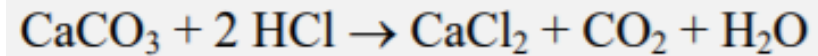
Stoichiometry

Calculate the amounts of Reactants and Products using the mole ratios in the **balanced equation**



Stoichiometry

Calcium carbonate reacts with hydrochloric acid to form calcium chloride, carbon dioxide, and water.



In one reaction, 54.6 g of CO_2 is produced. What the mass of HCl was consumed?

$$M_{\text{CO}_2} = 44 \text{ g/mol}$$

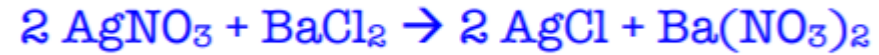
$$n = \frac{m}{M} = \frac{54.6}{44} = 1.24 \text{ mol}$$

| | Moles of CO_2 | Moles of HCl |
|--------------------------------|------------------------|--------------|
| من المعادلة الكيميائية | 1 | 2 |
| من المسألة بعد تحويلها إلى مول | 1.24 | x |

$$n \text{ HCl} = 2.48 \text{ mol}$$

$$m = 2.48 \times 36.46 = 90.42 \text{ g}$$

Silver nitrate reacts with barium chloride to form silver chloride and barium nitrate.



If 39.02 grams of barium chloride are reacted in an excess of silver nitrate, how many grams silver chloride are produced?

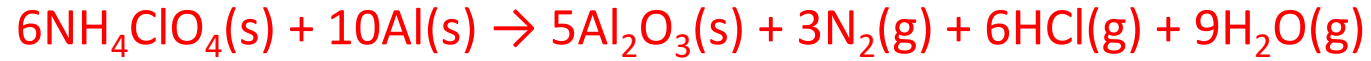
$$n(\text{BaCl}_2) = \frac{m}{M} = \frac{39.02}{208.23} = 0.187 \text{ mol}$$

| | Moles of BaCl_2 | Moles of AgCl |
|--------------------------------|--------------------------|------------------------|
| من المعادلة الكيميائية | 1 | 2 |
| من المسألة بعد تحويلها إلى مول | 0.187 | x |

$$n \text{ AgCl} = 0.375 \text{ mol}$$

$$m \text{ AgCl} = 0.375 \times 143.32 = 53.7 \text{ g}$$

According to the equation below:



What mass of aluminium should be mixed with 5.0×10^3 kg of ammonium perchlorate?

$$n(\text{NH}_4\text{ClO}_4) = \frac{m}{M} = \frac{5 \times 10^6}{117.49} = 4.25 \times 10^4 \text{ mol}$$

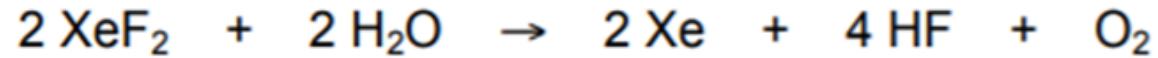
| | Moles of NH_4ClO_4 | Moles of Al |
|--------------------------------|------------------------------------|-------------|
| من المعادلة الكيميائية | 6 | 10 |
| من المسألة بعد تحويلها إلى مول | 4.25×10^4 | x |

$$n \text{ Al} = 7 \times 10^4 \text{ mol}$$

$$\text{Mass of Al} = 7 \times 10^4 \times 26.98 = 1.91 \times 10^6 \text{ g}$$

Limiting Reagent

When Xenon difluoride (XeF₂) dissolves in water, it slowly reacts with water to produce xenon gas, hydrogen fluoride and oxygen:



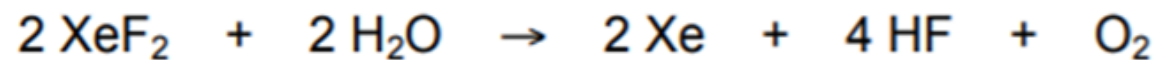
- (a) Which is the limiting reagent when 1.00 g of xenon difluoride is dissolved in 50.0 g of water?
(b) What mass of hydrogen fluoride can be produced and (c) how much of the excess reagent remains?



| | XeF ₂ | H ₂ O |
|-----------------------|--|---------------------|
| Convert to mol | 1/169.3 = 0.0059 mol | 50/18 = 2.78 |
| Divide by coefficient | 0.0059 / 2 = 0.0029 | 2.78/2 = 1.4 |
| | 0.0029 < 1.4 XeF ₂ is the limiting reagent H ₂ O is excess reagent | |

Steps:

1. Convert reactants into moles
2. Divide by coefficient
3. Reactants with small number (ratio) is limiting

(b) What mass of hydrogen fluoride can be produced





| | Moles of XeF_2 | Moles of HF |
|--|-------------------------|-------------|
| من المعادلة الكيميائية  | 2 | 4 |
| من المسألة بعد تحويلها إلى مول  | 0.0059 | x |

$$n \text{ HF} = 0.0118 \text{ mol}$$

$$\text{Mass of HF} = 0.0118 \times 20.01 = 0.236 \text{ g}$$

(c) how much of the excess reagent remains?

$$\text{grams of left} = \text{initial grams} - \text{reacted grams}$$

| | Moles of XeF_2 | Moles of H_2O |
|--|-------------------------|-------------------------------|
| من المعادلة الكيميائية  | 2 | 2 |
| من المسألة بعد تحويلها إلى مول  | 0.0059 | x |

$$n \text{ H}_2\text{O} = 0.0059 \text{ mol}$$

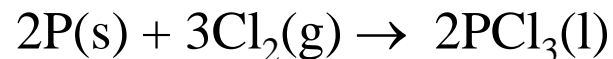
$$\text{Mass of H}_2\text{O} = 0.0059 \times 18.02 = 0.1064 \text{ g}$$

$$\text{grams of left} = 50 \text{ g} - 0.1064 \text{ g} = 49.9 \text{ g}$$

In a synthesis of phosphorus trichloride, a chemist mixed 12.0 g P with 35.0 g Cl₂; she obtained 42.4 g of PCl₃. What is the % yield of PCl₃?

Actual Yield is always less and normally given in the question

Actual yield = 42.4 g

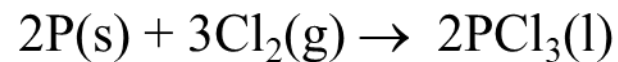


$$\% \text{ Yield} = \frac{\text{Actual Yield}}{\text{Theoretical Yield}} \times 100$$

1- You need to determine limiting reagent

| | P | Cl |
|-----------------------|--|------------------------|
| Convert to mol | 12/30.97= 0.9687 mol | 35/71 = 0.493 mol |
| Divide by coefficient | 0.9687/2 = 0.484 | 0.493/3 = 0.164 |
| | 0.164 < 0.484 Cl ₂ is the limiting reagent | |

2- Calculate the theoretical yield of PCl_3



من المعادلة الكيميائية
من المسألة بعد تحويلها إلى مول

| Moles of Cl_2 | Moles of PCl_3 |
|------------------------|-------------------------|
| 3 | 2 |
| 0.493 | x |

$$n \text{ PCl}_3 = 0.3286 \text{ mol}$$

$$\text{Mass of PCl}_3 = 0.3286 \times 137.33 = 45.13 \text{ g}$$

3- % yield of PCl_3

$$\% \text{ Yield} = \frac{42.4}{54.13} \times 100 = 93.9 \%$$