Mass as a means to count

How do you count very small particles in large amounts?

What does an equation represent?

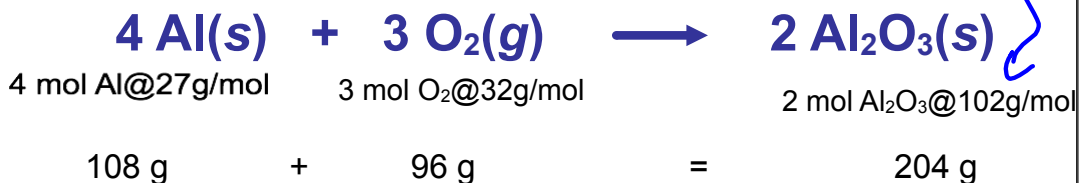$$4 \, Al(s) \; + \; 3 \, O_2(g) \longrightarrow 2 \, Al_2O_3(s)$$

Draw a representation of particles:

> 4 Al atoms + 3 O_2 molecules yield 2 molecules of Al_2O_3
> ## or
> 4 Al *moles* + 3 O_2 *moles* yield 2 *moles* of Al_2O_3

coefficients do not mean mass

4 g Al + 3 g O_2 yield 2 g Al_2O_3

Al 2 ×27 = 54
O 3×16 = 48

Use moles to determine mass

$$4 \, Al(s) \; + \; 3 \, O_2(g) \longrightarrow 2 \, Al_2O_3(s)$$

4 mol Al@27g/mol   3 mol O_2@32g/mol   2 mol Al_2O_3@102g/mol

108 g   +   96 g   =   204 g

Law of Conservation of Mass

Mass is never created or destroyed

Stoichiometric Conversions

LITERS OF GAS AT STP

Molar Volume
(22.4 L/mol)

MASS IN GRAMS

Molar Mass
(g/mol)

MOLES

6.02×10^{23}
particles/mol

NUMBER OF PARTICLES

use periodic table

Avagadro's number
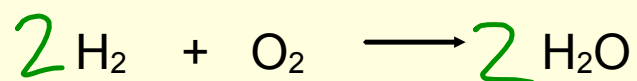
Stoic Calculations
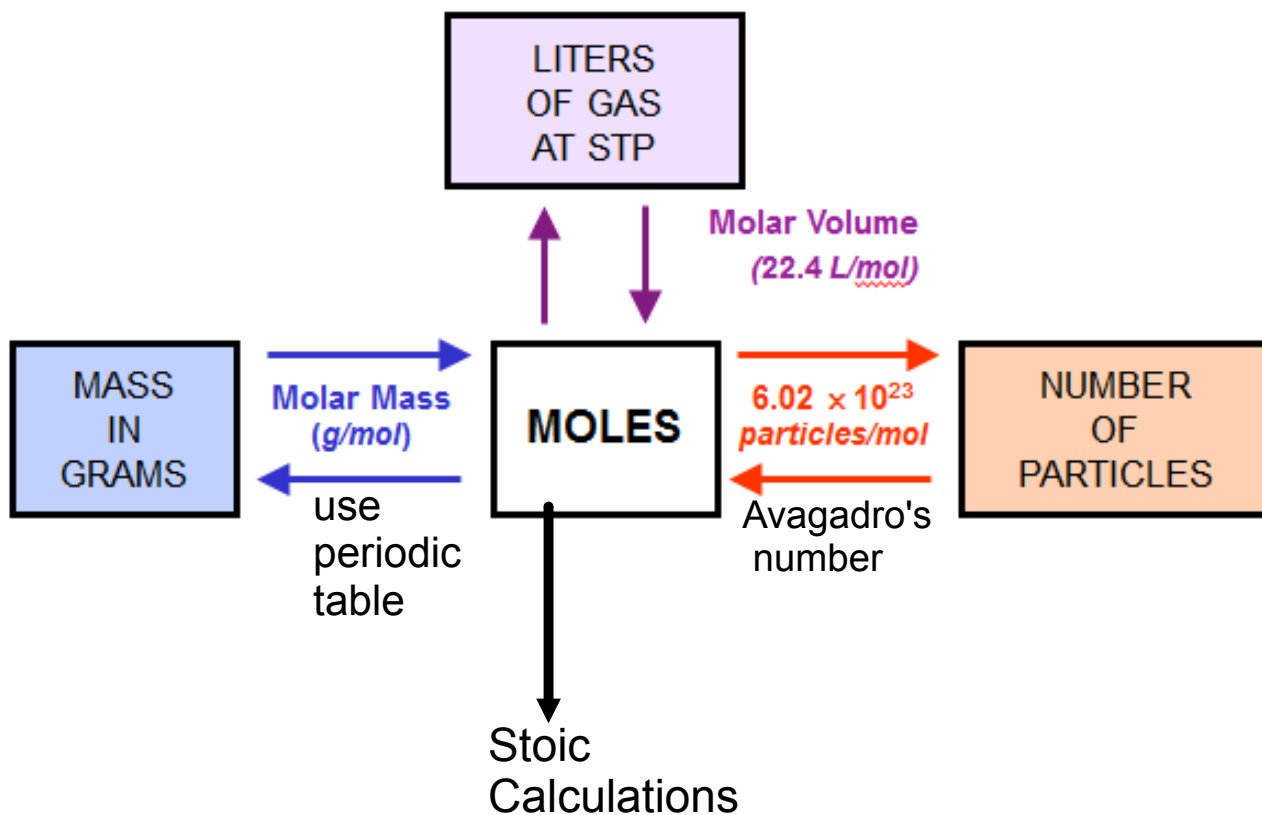
(ISE table limiting reactant, excess)
Use moles or particles. Do not use mass!

Gram to Gram Problem

If I have 75 grams of H_2, how many grams of O_2 will react with it?

$$2\,H_2 \;+\; O_2 \longrightarrow 2\,H_2O$$

Mass to Mass Stoich problems

How many grams of potassium chloride are produced if 25 g of potassium chlorate decompose?

$$2 \; KClO_3 \longrightarrow 2 \; KCl \; + \; 3O_2$$

How many grams of oxygen will be produced with same starting amount?

Mass to Mass Stoich problems

How many grams of potassium chloride are produced if 25 g of potassium chlorate decompose?

$$g \xrightarrow{KClO_3} mol \xrightarrow{KCl} mol \xrightarrow{} gKCl$$

$$2\ KClO_3 \longrightarrow 2\ KCl \ + \ 3O_2$$

$$25g \ = \ 15.2g \ + \ 9.8g$$
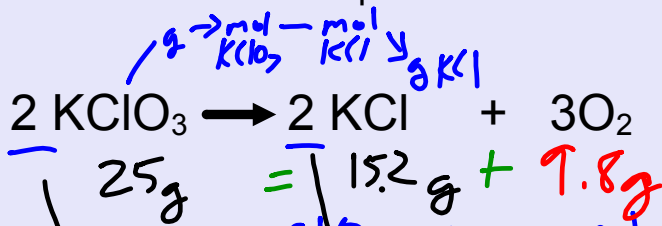
$$g\ KClO_3 \rightarrow mol\ KClO_3 \rightarrow mol\ KCl \searrow g\ KCl$$

Reaction Coeff.

(P.T.)   (P.T.)

$$25g\ KClO_3 \ \Big|\ \frac{1\ mol\ KClO_3}{122.5g\ KClO_3}\ \Big|\ \frac{2\ \frac{mol}{KCl}}{2\ KClO_3}\ \Big|\ \frac{74.5\ g\ KCl}{1\ mol\ KCl}$$

(P.T.)

$$= \boxed{15.2\ g \\ KCl}$$

$KClO_3$
K 39
Cl 35.5
O 3×16=48
$\overline{122.5g/mol}$

KCl
K 39
Cl 35.5
$\overline{74.5 g/mol}$

O_2
16×2
$32 g/mol$

coeff.
Reaction

PT   PT

$$25g\ KClO_3 \ \Big|\ \frac{1\ mol\ KClO_3}{122.5g\ KClO_3}\ \Big|\ \frac{3\ mol\ O_2}{2\ mol\ KClO_3}\ \Big|\ \frac{32g\ O_2}{1\ mol\ O_2}$$

$$9.8\ g\ O_2$$

How many grams of ammonia are formed if I start with 50.0g of nitrogen

$$N_2 \ + \ 3H_2 \longrightarrow 2NH_3$$
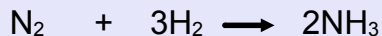
How many grams of ammonia are formed if I start with 50.0g of H_2

STOICHIOMETRY:
MASS-MASS PROBLEMS

Name _MCD 7_

1. $2KClO_3 \rightarrow 2KCl \ + \ 3O_2$

   How many grams of potassium chloride are produced if 25 g of potassium chlorate decompose?   KCl
   K 39.1
   Cl 35.5

   KClO_3
   K 39.1(1)=39.5
   Cl 35.5(1)=35.5   74.6g/mol
   O 16(3)= 48
   123g/mol

   $25g \ KClO_3 \left(\dfrac{1 mol \ KClO_3}{123g \ KClO_3} \right) \left(\dfrac{2 mol \ KCl}{2 mol \ KClO_3} \right) \left(\dfrac{74.6g \ KCl}{1 mol \ KCl} \right) =$ 15.2 gK

2. $N_2 \ + \ 3H_2 \ \rightarrow \ 2NH_3$

   How many grams of hydrogen are necessary to react completely with 50.0 g of nitrogen in the above reaction?

   $H_2 = 2g/mol$
   $N_2 = 28g/mol$

   $50g \ N_2 \left(\dfrac{1 mol \ N_2}{28g \ N_2} \right) \left(\dfrac{3 mol \ H_2}{1 mol \ N_2} \right) \left(\dfrac{2 \ g \ H_2}{1 \ mol \ H_2} \right) =$

   10.71 g H_2

3. How many grams of ammonia are produced in the reaction in Problem 2?

   N(1) 14=14
   H(3) 1=3
   17g/mol

   $50g \ N_2 \left(\dfrac{1 mol \ N_2}{28g \ N_2} \right) \left(\dfrac{2 mol \ NH_3}{1 mol \ N_2} \right) \left(\dfrac{17g \ NH_3}{1 mol \ NH_3} \right)$

   60.7 g NH_3

4. $2AgNO_3 \ + \ BaCl_2 \ \rightarrow \ 2AgCl + Ba(NO_3)_2$

   How many grams of silver chloride are produced from 5.0 g of silver nitrate reacting with an excess of barium chloride?

   Ag(1) 107.9=107.9
   N(1) 14 =14
   O (3) 16 =48
   169.9g/mol

   $5.0g \ AgNO_3 \left(\dfrac{1 mol \ AgNO_3}{169.9g \ AgNO_3} \right) \left(\dfrac{1 mol \ AgCl}{2 mol \ AgNO_3} \right) \left(\dfrac{143.4g \ AgCl}{1 mol \ AgCl} \right)$

   Ag(1) 107.9
   Cl(1) 35.5/mol

   2.11 g AgCl

5. How much barium chloride is necessary to react with the silver nitrate in Problem 4?

   Ba(1) 9.0   9
   Cl(2) 35.5 71
   80g/mol

   $5.0 AgNO_3 \left(\dfrac{1 mol \ AgNO_3}{169.9g \ AgNO_3} \right) \left(\dfrac{1 mol \ BaCl_2}{2 mol \ AgNO_3} \right) \left(\dfrac{80g \ BaCl_2}{1 mol \ BaCl_2} \right)$
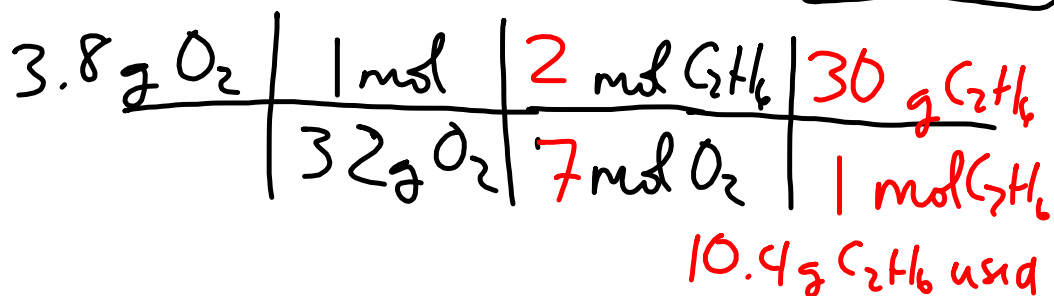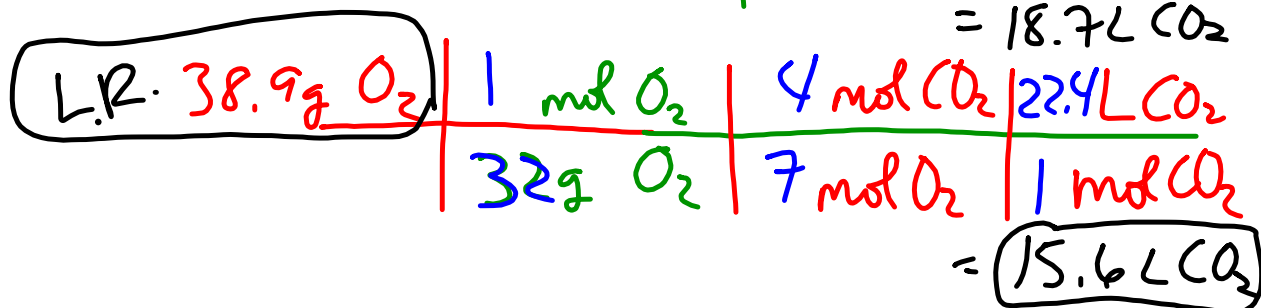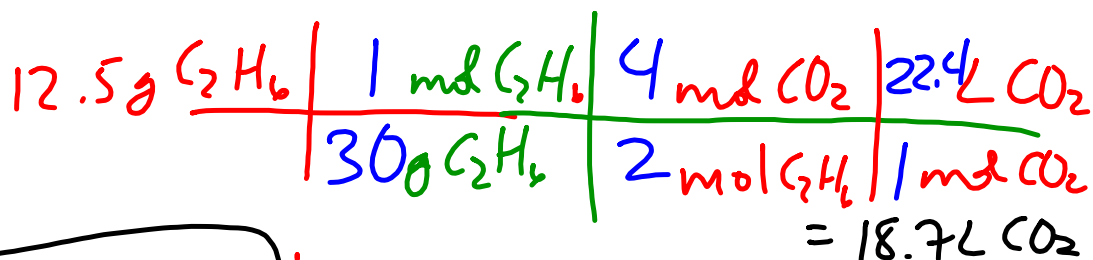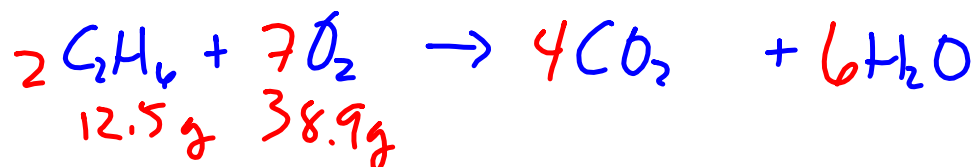
   1.18 g BaCl_2

Limiting Reactant and excess

How many grams of ammonia are formed if I start with 50.0g of nitrogen and 50 grams of H_2 .

$$N_2 \quad + \quad 3H_2 \longrightarrow \quad 2NH_3$$

p.110

$$2 C_2H_6 + 7 O_2 \rightarrow 4 CO_2 + 6 H_2O$$
12.5 g   38.9 g

$$\dfrac{12.5 \text{ g } C_2H_6}{} \left| \dfrac{1 \text{ mol } C_2H_6}{30 \text{ g } C_2H_6} \right| \dfrac{4 \text{ mol } CO_2}{2 \text{ mol } C_2H_6} \left| \dfrac{22.4 \text{ L } CO_2}{1 \text{ mol } CO_2} \right.$$

= 18.7 L CO₂

L.R. $\dfrac{38.9 \text{ g } O_2}{} \left| \dfrac{1 \text{ mol } O_2}{32 \text{ g } O_2} \right| \dfrac{4 \text{ mol } CO_2}{7 \text{ mol } O_2} \left| \dfrac{22.4 \text{ L } CO_2}{1 \text{ mol } CO_2} \right.$

= 15.6 L CO₂

$$\dfrac{3.8 \text{ g } O_2}{} \left| \dfrac{1 \text{ mol}}{32 \text{ g } O_2} \right| \dfrac{2 \text{ mol } C_2H_6}{7 \text{ mol } O_2} \left| \dfrac{30 \text{ g } C_2H_6}{1 \text{ mol } C_2H_6} \right.$$
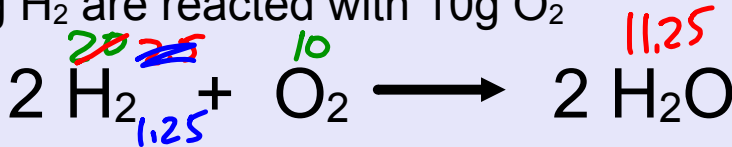
10.4 g C₂H₆ used
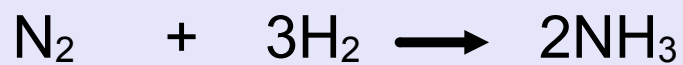
12.5 g
10.4
2.1 g excess C₂H₆

What is the limiting reactant, exess reactant and
amount of product that can be made?

20g H_2 are reacted with 10g O_2

20 20 | 10 | 11.25

$$2\ H_2 + O_2 \longrightarrow 2\ H_2O$$

1.25

only use **particles**
or **moles** in
ISE table!
Do not use grams!

I
S
E

must convert to

ex 20g H_2 | $\dfrac{1\ mol\ H_2}{2\ g\ H_2}$ | $\dfrac{2\ mol\ H_2O}{2\ mol\ H_2}$ | $\dfrac{18\ g\ H_2O}{1\ mol\ H_2O}$ = 180g H_2O

PT   rxn   PT

2 / 16

H_2 | 1×2=2 g/mol | O_2 2×16=32 g/mol | H_2O 18 g/mol

LR | 10g O_2 | $\dfrac{1\ mol\ O_2}{32\ g\ O_2}$ | $\dfrac{2\ mol\ H_2O}{1\ mol\ O_2}$ | $\dfrac{18\ g\ H_2O}{1\ mol\ H_2O}$ = 11.25g H_2O

$$10\ g\ O_2\ \Big|\ \dfrac{1\ mol\ O_2}{32\ g\ O_2}\ \Big|\ \dfrac{2\ mol\ H_2}{1\ mol\ O_2}\ \Big|\ \dfrac{2\ g\ H_2}{1\ mol\ H_2} = \dfrac{1.25}{7}\ H_2$$

2 Sb + 3 Cl$_2$ → 2 SbCl$_3$

How many grams of chlorine gas are required to react with 8 grams of antimony?

How many grams of SbCl$_3$ are produced from 109 grams of Cl$_2$ and excess Sb?

How many grams of $KClO_3$ must decompose in order to produce 25 grams of oxygen gas?

$$2\ KClO_3 \longrightarrow 2\ KCl\ +\ 3\ O_2$$