Example:

How many grams of sodium carbonate is needed to make 15.5 grams of sodium chloride, assuming there is sufficient hydrochloric acid for the reaction

$$2HCl(aq) + Na_2CO_3(s) \longrightarrow H_2O(l) + CO_2(g) + 2NaCl(aq)$$

1 - Convert 15.5 g NaCl to moles. Use FORMULA WEIGHT of NaCl.
2 - Convert moles NaCl to moles sodium carbonate. Use the ratio in the CHEMICAL EQUATION
3 - Convert moles sodium carbonate to grams. Use FORMULA WEIGHT.

(1) NaCl: Na: 1 x 22.99
Cl: 1 x 35.45

58.44 g NaCl = mol NaCl

$$15.5\ g\ NaCl \times \frac{mol\ NaCl}{58.44\ g\ NaCl} = 0.265229295\ mol\ NaCl$$

(2) $mol\ Na_2CO_3 = 2\ mol\ NaCl$

$$0.265229295\ mol\ NaCl \times \frac{mol\ Na_2CO_3}{2\ mol\ NaCl} = 0.1326146475\ mol\ Na_2CO_3$$

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(3) Na_2CO_3: Na : 2 x 22.99
C : 1 x 12.01
O : 3 x 16.00

$105.99\ g\ Na_2CO_3 = mol\ Na_2CO_3$

$$0.1326146475\ mol\ Na_2CO_3 \times \frac{105.99\ g\ Na_2CO_3}{mol\ Na_2CO_3} = \boxed{14.1\ g\ Na_2CO_3}$$

EXAMPLE PROBLEM:

$$2\,Na(s) + Cl_2(g) \rightarrow 2\,NaCl(s)$$

How many grams of sodium metal is required to completely react with 2545 grams of chlorine gas?

1 - Convert 2545g chlorine gas to moles. Use formula weight.
2 - Convert moles chlorine gas to moles sodium using chemical equation
3 - Convert moles sodium to mass sodium. Use formula weight,

Cl_2: 2 x 35.45 : 70.90 g Cl_2 = mol Cl_2 (1)

2 mol Na = mol Cl_2 (2)

Na: 22.99 g Na = mol Na (3)

$$2545\,g\,Cl_2 \times \underset{(1)}{\frac{mol\,Cl_2}{70.90\,g\,Cl_2}} \times \underset{(2)}{\frac{2\,mol\,Na}{mol\,Cl_2}} \times \underset{(3)}{\frac{22.99\,g\,Na}{mol\,Na}} = \boxed{1650.\,g\,Na}$$

42.081 g/mol — 53.064 g/mol

$$4\,C_3H_6 + 6\,NO \longrightarrow 4\,C_3H_3N + 6\,H_2O + N_2$$

propylene — acrylonitrile

Calculate how many grams of acrylonitrile could be obtained from 651 kg of propylene, assuming there is excess NO present.

1 - Convert 651 kg propylene to moles. Use formula weight and a kg -> g conversion.
2 - Convert moles propylene to moles acrylonitrile. Use chemical equation.
3 - Convert moles acrylonitrile to mass (grams) acrylonitrile. Use formula weight.

$42.081\,g\ C_3H_6 = mol\ C_3H_6$ | $kg = 10^3\,g$ | $4\,mol\ C_3H_6 = 4\,mol\ C_3H_3N$

$53.064\,g\ C_3H_3N = mol\ C_3H_3N$

$$651\,kg\ C_3H_6 \times \frac{10^3\,g}{kg} \times \frac{mol\ C_3H_6}{42.081\,g\ C_3H_6} \times \frac{4\,mol\ C_3H_3N}{4\,mol\ C_3H_6} \times \frac{53.064\,g\ C_3H_3N}{mol\ C_3H_3N} =$$

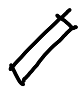
(1) (2) (3)

$$= \boxed{821000\,g\ C_3H_3N}$$

CONCEPT OF LIMITING REACTANT

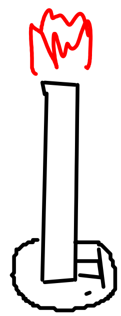
- When does a chemical reaction STOP?

$$2Mg(s) + O_2(g) \xrightarrow{\Delta} 2MgO(s)$$



Magnesium strip

+



Flame, oxygen from air

Magnesium oxide powder

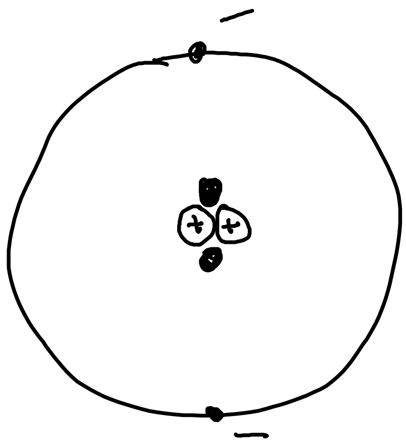
- When does this reaction stop? When burned in open air, this reaction stops when all the MAGNESIUM STRIP is gone. We say that the magnesium is LIMITING.

- This reaction is controlled by the amount of available magnesium

- At the end of a chemical reaction, the LIMITING REACTANT will be completely consumed, but there may be some amount of OTHER reactants remaining. We do chemical calculations in part to minimize these "leftovers".

- Reactants that are left at the end of a chemical reaction (in other words, they are NOT the limiting reactant) are often called "excess". So reacting magnesium with "excess oxygen" means that magnesium is limiting.

STRUCTURE OF THE ELECTRON CLOUD



The nuclear model describes atoms as consisting of a NUCLEUS containing protons and neutrons and an ELECTRON CLOUD containing electrons.

The ELECTRON CLOUD is described as being a diffuse (lots of empty space) region of the atom. Nothing else about it is part of the nuclear model.

... but the nuclear model is not useful to explain several things:

- Does not explain why atoms react differently from one another
- Does not explain how atoms emit and absorb light (atomic line spectra)