-- involves finding amts. of reactants & products in a reaction

What can we do with stoichiometry?

For generic equation: R_A + R_B → P_1 + P_2

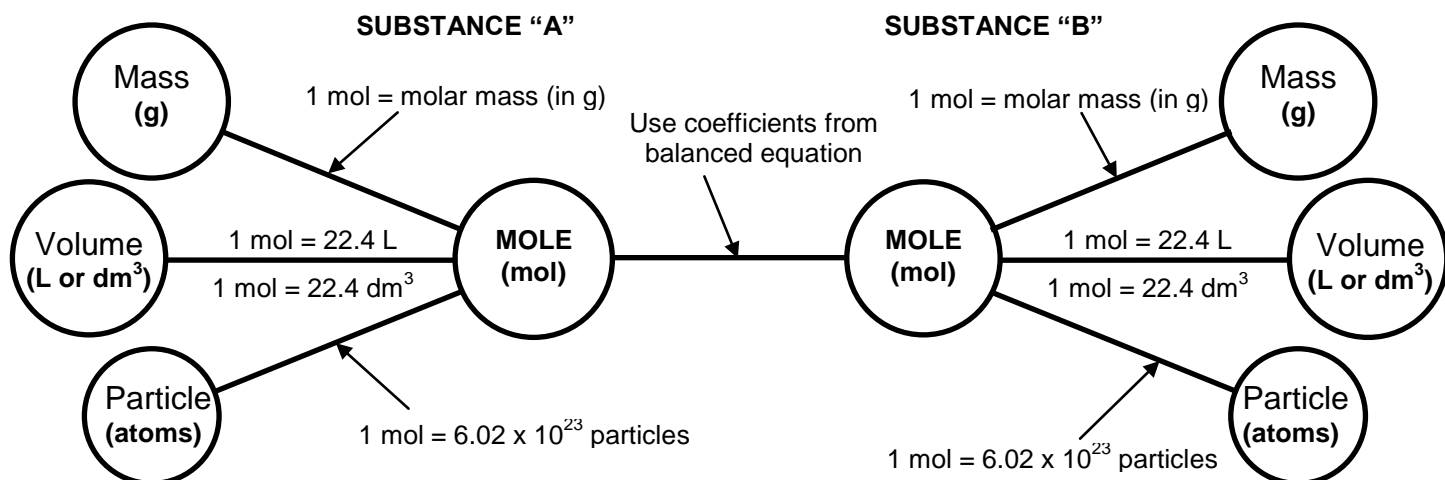| Given the…	…one can find the…
amount of R_A (or R_B)	**amount of R_B (or R_A) that is needed to react with it**
amount of R_A or R_B	**amount of P_1 or P_2 that will be produced**
amount of P_1 or P_2 you need to produce	**amount of R_A and/or R_B you must use**

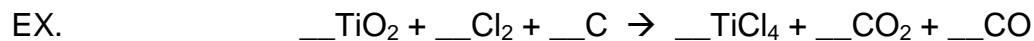Governing Equation: 2 patties   +   3 bread   →   1 Big Mac®

4 patties   +   ?

excess   + 18 bread   →   ?

?   +   ?   →   25 Big Macs®

Stoichiometry Island Diagram

EX.   __TiO$_2$ + __Cl$_2$ + __C → __TiCl$_4$ + __CO$_2$ + __CO

How many mol chlorine will react with 4.55 mol carbon?

What mass titanium (IV) oxide will react with 4.55 mol carbon?

How many molecules titanium (IV) chloride can be made from 115 g titanium (IV) oxide?

Island Diagram helpful reminders:

1. Use coefficients from the equation only when crossing the middle bridge. The other six
   bridges always have "1 mol" before a substance's formula.

2. The middle bridge conversion factor is the only one that has two different substances in it.
   The conversion factors for the other six bridges have the same substance in both the
   numerator and denominator.

3. The units on the islands at each end of the bridge being crossed appear in the conversion
   factor for that bridge.

EX.   2 Ir + Ni$_3$P$_2$ → 3 Ni + 2 IrP
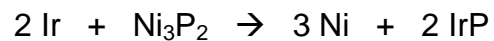
If 5.33 x 10^{28} m'cules nickel (II) phosphide react ^{W}/excess iridium, what mass iridium (III) phosphide is produced?

How many grams iridium will react with 465 grams nickel (II) phosphide?

How many moles of nickel are produced if 8.7 x 10^{25} atoms of iridium are consumed?

EX. What volume hydrogen gas is liberated (at STP) if 50 g zinc react ^{W}/excess hydrochloric acid (HCl)?

EX. At STP, how many m'cules oxygen react ^{W}/632 dm^3 butane (C$_4$H$_{10}$)?

Energy and Stoichiometry $CH_4(g) + 2 O_2(g) \rightarrow CO_2(g) + 2 H_2O(g) + 891$ kJ
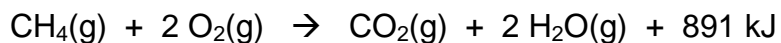
How many kJ of energy are released when 54 g methane are burned?

At STP, what volume oxygen is consumed in producing 5430 kJ of energy?

What mass of water is made if 10,540 kJ are released?

The Limiting Reactant

A balanced equation for making a Big Mac® might be: $3 B + 2 M + EE \rightarrow B_3M_2EE$

With…	…and…	…one can make…
30 M	excess B and excess EE	
30 B	excess M and excess EE	
30 M	30 B and excess EE	

A balanced equation for making a tricycle might be: $3 W + 2 P + S + H + F \rightarrow W_3P_2SHF$

With…	…and…	…one can make…
50 P	excess of all other reactants	
50 S	excess of all other reactants	
50 P	50 S and excess of all other reactants	

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Solid aluminum reacts ^{W}/chlorine gas
to yield solid aluminum chloride.   **2** Al(s) +   **3** Cl$_2$(g) →   **2** AlCl$_3$(s)
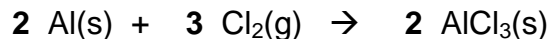
If 125 g aluminum react ^{W}/excess chlorine, how many g aluminum chloride are made?

If 125 g chlorine react ^{W}/excess aluminum, how many g aluminum chloride are made?

If 125 g aluminum react ^{W}/125 g chlorine, how many g aluminum chloride are made?

limiting reactant (LR): the reactant that runs out first.

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Any reactant you don't run out of is an excess reactant (ER).

From Examples Above…	Limiting Reactant	Excess Reactant(s)
Big Macs		
tricycles		
Al / Cl$_2$ / AlCl$_3$		

How to Find the Limiting Reactant

For the generic reaction   R$_A$ + R$_B$ → P, assume that the amounts of R$_A$ and R$_B$
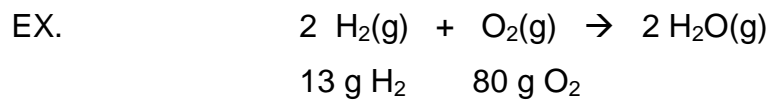are given. Should you use R$_A$ or R$_B$ in your calculations?

        1. Calc. # of mol of R$_A$ and R$_B$ you have.
        2. Divide by the respective coefficients in balanced equation.
        3. Reactant having the smaller result is the LR.

For the Al / Cl_2 / $AlCl_3$ example:

EX. $2\ Fe(s)$ + $3\ Cl_2(g)$ → $2\ FeCl_3(s)$

223 g Fe   179 L Cl_2
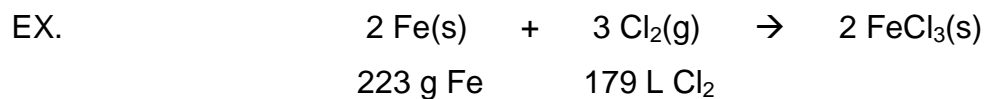
Which is the limiting reactant: Fe or Cl_2?

How many g $FeCl_3$ are produced?

EX. $2\ H_2(g)$ + $O_2(g)$ → $2\ H_2O(g)$

13 g H_2 80 g O_2

Which is LR: H_2 or O_2?

How many g H_2O are formed?

How many g O_2 are left over?

How many g H_2 are left over?

EX.   2 Fe(g) + 3 Br$_2$(l) → 2 FeBr$_3$(s)

                          181 g Fe   96.5 L Br$_2$
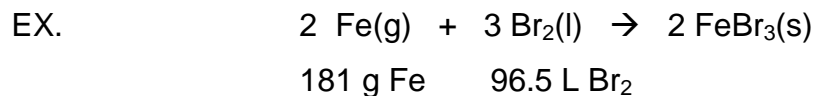
        Find LR.

        How many g FeBr$_3$ are formed?

        How many g of the ER are left over?

| Percent Yield | molten + solid   →   molten   +   solid
                      sodium   aluminum   aluminum   sodium
                                 oxide   oxide
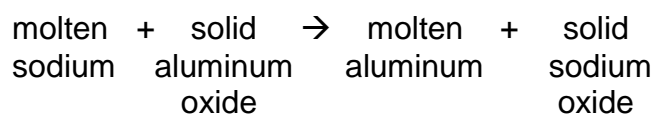
EX. Find mass of aluminum produced if you start ^{W}/575 g sodium and 357 g aluminum oxide.

This amount of product is the theoretical yield.

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Now suppose that we perform this reaction and get only 172 grams of aluminum. Why?

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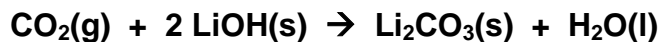$$\boxed{\% \ yield = \frac{actual \ yield}{theoretical \ yield} \times 100}$$

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EX. Find % yield for previous problem.

EX. Reaction that powers space shuttle is: **2 H$_2$(g) + O$_2$(g) → 2 H$_2$O(g) + 572 kJ**

From 100 g hydrogen and 640 g oxygen, what amount of energy is possible?

What mass of excess reactant is left over?

EX. On NASA spacecraft, lithium hydroxide "scrubbers" remove toxic CO$_2$ from cabin.

CO$_2$(g) + 2 LiOH(s) → Li$_2$CO$_3$(s) + H$_2$O(l)

For a seven-day mission, each of four individuals exhales 880 g CO$_2$ daily. If reaction is 75% efficient, how many g LiOH should be brought along?
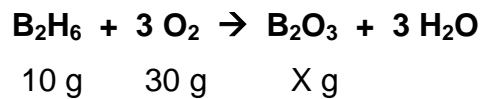
EX. Automobile air bags inflate with nitrogen via the decomposition of sodium azide:
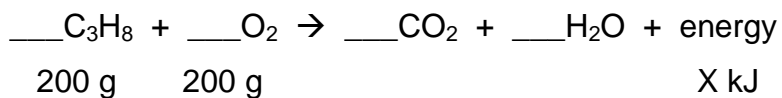
$$2\ NaN_3(s) \rightarrow 3\ N_2(g)\ +\ 2\ Na(s)$$

At STP and a % yield of 85%, what mass sodium azide is needed to yield 74 L nitrogen?

EX.
$$B_2H_6\ +\ 3\ O_2 \rightarrow B_2O_3\ +\ 3\ H_2O$$
$$10\ g \qquad 30\ g \qquad X\ g$$

EX.
___C_3H_8 + ___O_2 → ___CO_2 + ___H_2O + energy

200 g   200 g   X kJ

Strategy: 1.

2.

EX.   ___ZnS + ___O₂ → ___ZnO + ___SO₂

        100 g   100 g   X g (assuming 81% yield)

Strategy: 1.

               2.

               3.

EX.   ___Al + ___Fe₂O₃ → ___Fe + ___Al₂O₃

                         X g   X g   800 g needed   **Rxn. has an 80% yield.