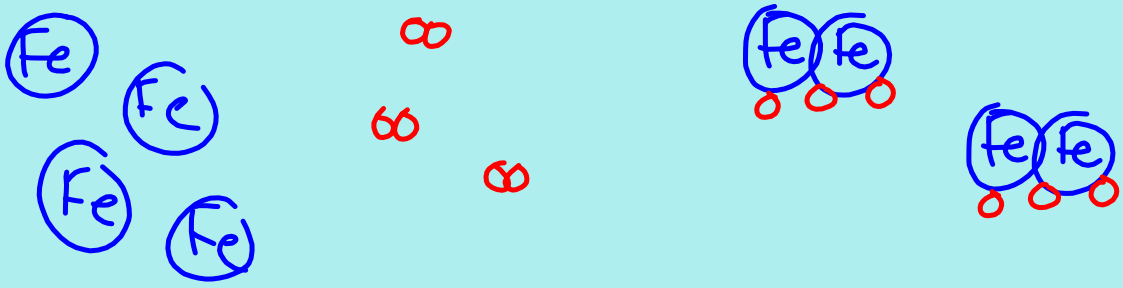
Stoichiometry

"stochio" = element (Greek)
"metry" = measurement

Stoichiometry is about measuring the amounts of elements and compounds involved in a reaction

stoichiometric coefficients:
numbers to balance reaction

4 Fe + **3** O_2 ⟶ **2** Fe_2O_3

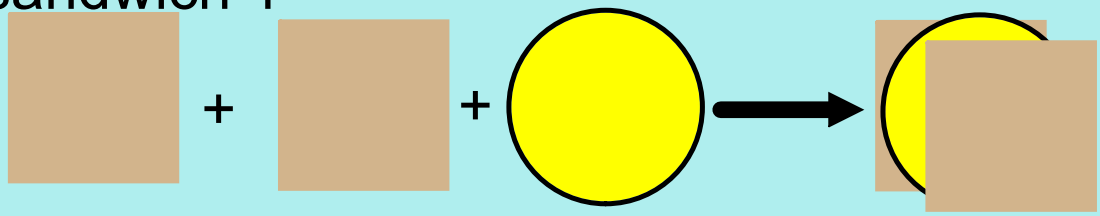


Suppose you are preparing cheese sandwiches.
Each sandwich requires
2 pieces of bread and 1 slice of cheese.
You have:
4 slices of cheese
10 pieces of bread

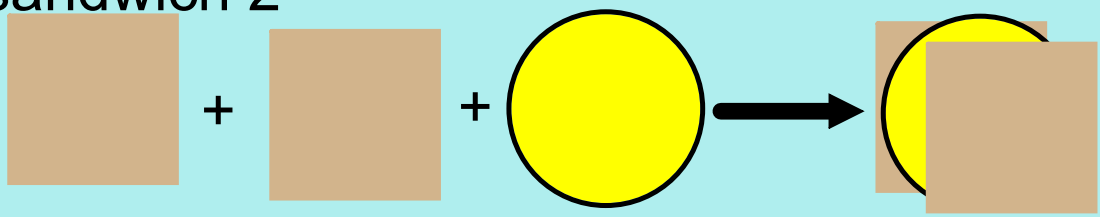
How many cheese sandwiches can you make?

Cheese Sandwich Products

sandwich 1



sandwich 2



Max amount determined by
1. Quantity available
2. Rate of "use"

How many sandwiches can you make?

10 slices of bread
+ 4 slices of cheese
= 4 sandwiches

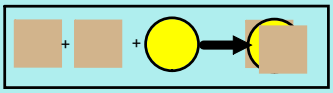
What is left over (excess)? 2 slices of bread

What is the limiting reactant? cheese

- used up in a reaction
- determines amount of reactants used and products created

Max amount determined by
1. Quantity available
2. Rate of "use"

ISE Table



need balanced equation

2 Br + **1** Ch → **1** Br_2Ch

Initial (start)	I	10	4	0
Stoicheometric change (+ or -)	S	-8	-4	+4
End	E	2 excess	0 L.R. limiting reactant	4

Steps

1. Balance Equation and set up ISE table
2. Determine limiting reactant/excess reactant:
   For each reactant amount given, calculate the proportional amount of a product it could produce.

$$10 \text{ pieces Br} \left| \frac{1 \ Br_2Ch}{2 \ Br} \right. = 5 \ Br_2Ch$$

Larger answer indicates excess reactant

$$4 \text{ pieces Ch} \left| \frac{1 \ Br_2Ch}{1 \ Ch} \right. = 4 \ Br_2Ch$$

Smaller answer indicates the amount of product indicates limiting reactant.

Everything is based on the limiting reactant

3. Determine amounts of excess reactant and products:

Use limiting reactant to calculate actual amount of other reactant used and products produced (In "S" row of ISE table)

L.R.

$$4 \text{ pieces Ch} \left| \frac{2 \ Br}{1 \ Ch} \right. = 8 \ Br$$

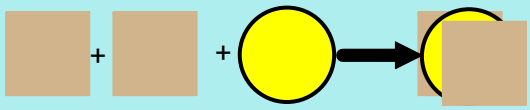
8 Br used = -8

4. Calculate "end" amounts after the reaction by adding or subtracting first two rows. (In row "E" of ISE table)

Jan 25-2:15 AM

STEPS (continued)

ISE Table



		2 Br	+ 1 Ch	→ 1 Br_2Ch
Initial (start)	**I**	10	4	0
Stoicheometric change (+ or -)	**S**	-8	-4	+4
End	**E**	2	0	4

excess reactant

limiting reactant

3. Determine amounts of excess reactant and products:

Use limiting reactant to calculate actual amount of other reactant used and products produced (In "S" row of ISE table)

$$\frac{4 \text{ pieces Ch}}{1 \text{ Ch}} \left| \frac{2 \text{ Br}}{} \right. = 8 \text{ Br}$$

8 Br used = -8

Fill in rest of "S" row of ISE table (calculated already)

$$\frac{4 \text{ pieces Ch}}{1 \text{ Ch}} \left| \frac{1 \text{ } Br_2Ch}{} \right. = 4 \text{ } Br_2Ch$$

4 Br_2Ch produced = +4

Calculate amounts after the reaction by adding or subtracting first two rows. (In row "E" of ISE table)

Jan 25-2:15 AM

500 atoms of Fe react with 600 molecules of 0_2

What is the limiting reactant, amount of excess reactant, and amount of product?

1. Balance Equation and set up ISE table

	4 Fe	+	3 O_2	→	2 Fe_2O_3
I	500		600		0
S	−500		−375		+250
E	0		225		250

2. Determine limiting reactant/excess reactant:

$$\frac{500\ Fe \mid 2\ Fe_2O_3}{4\ Fe} = 250 \text{ molecules } Fe_2O_3$$

$$\frac{600\ O_2 \mid 2\ Fe_2O_3}{3\ O_2} = 400 \text{ molecules } Fe_2O_3$$

(excess)

3. Determine amount of excess reactant:

$$\frac{500\ Fe \mid 3\ O_2}{4\ Fe} = 375 \text{ molecules } O_2$$

use table to subtract amount used

500 water molecules decompose to elements

$2H_2O \longrightarrow 2H_2 + 1O_2$

	$2H_2O$	$2H_2$	$1O_2$
I	500	0	0
S	-500	+500	+250
E	0	500	250

If there is only one reactant, then it must be the limiting reactant.

$500\ H_2O \left| \frac{2\ H_2}{2\ H_2O} \right. = 500\ H_2$

$500\ H_2O \left| \frac{1\ O_2}{2\ H_2O} \right. = 250\ O_2$

$1\,CH_4 + 2\,O_2 \rightarrow 1\,CO_2 + 2\,H_2O$

	CH_4	O_2	CO_2	H_2O
I	300	500	0	0
S	-250	-500	+250	+500
E	50	0	250	500

excess

$300\ CH_4 \left| \frac{1\ CO_2}{1\ CH_4} \right. = 300\ CO_2$

LR

$500\ O_2 \left| \frac{1\ CO_2}{2\ O_2} \right. = 250\ CO_2$

LR

$500\ O_2 \left| \frac{1\ CH_4}{2\ O_2} \right. = 250\ CH_4$

LR

$500\ O_2 \left| \frac{2\ H_2O}{2\ O_2} \right. = 500\ H_2O$

Feb 6-7:43 AM

p. 101, #1

$2Al + 3S \longrightarrow Al_2S_3$

	250	700	0
I Initial			
S stoich change	-250	-375	+125
End	0	325	125

LR

$\frac{250\ Al}{2\ Al} \left| \frac{3\ S}{} \right. = 375\ S$

cost

LR: Base everything

$\frac{250\ Al}{2\ Al} \left| \frac{1\ Al_2S_3}{} \right. = 125\ Al_2S_3$ (less)

excess

$\frac{700\ S}{3\ S} \left| \frac{1\ Al_2S_3}{} \right. = 233\ Al_2S_3$ more

Stoic -- one reactant in exess
Base all amounts on given reactant

2R

$H_2S + 2OH^{-1} \longrightarrow S^{-2} + 2H_2O$

I 550 excess 0

S -550 -1100 +550 +1100

0 ?

$550\ H_2S \left| \frac{2\ OH^-}{1\ H_2S} \right. = 1100\ OH^-$

$550\ H_2S \left| \frac{1\ S^{-2}}{1\ H_2S} \right. = 550\ S^{-2}$

$550\ H_2S \left| \frac{2\ H_2O}{1\ H_2S} \right. = 1100\ H_2O$

page 100, #1

$C_7H_{16} + 11O_2 \longrightarrow 7CO_2 + 8H_2O$

502,300,000 excess

$502{,}300{,}000\ g\ C_7H_{16} \left| \frac{11\ O_2}{1\ C_7H_{16}} \right. = 5.525 \times 10^9\ g\ O_2$

$502{,}300{,}000\ g\ C_7H_{16} \left| \frac{7\ CO_2}{1\ C_7H_{16}} \right. = 3.516 \times 10^9\ g\ CO_2$

$502{,}300{,}000\ g\ C_7H_{16} \left| \frac{8\ H_2O}{1\ C_7H_{16}} \right. = 4.018 \times 10^9\ g\ H_2O$