N-28
Limiting Reagent Stoichiometry

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Limiting Reagent Stoichiometry

Target: I can determine which substance will run out first during a reaction so that I can perform "limiting reagent stoichiometry."

Link to YouTube Presentation: https://youtu.be/iUjL9AVeSnU

Pros and Cons to all methods

- You have to be careful with rounding when using this method.
- But it is faster, less likely to make mistakes, and safer when it comes to getting partial credit.
- If you need help – come see me! Don't start looking things up online, it confuses more people than I've seen it help. Please let me help you! ☺

The “danger” of looking up videos & examples of limiting stoich online…

There are so many weird little tricks, other methods, etc. But they don’t all ADEQUATELY show units, concepts, etc.

If you want to demonstrate mastery of the CONCEPTS to get full points, use this method.

Not all teachers use this method, but you’re stuck with me…

#sorrynotsorry ☺ Ha!

Limiting Reagent Stoichiometry:

A type of stoich problem where you run out of one chemcial too soon, and have extra of the other chemical left over

How do I know if it is a "regular" stoichiometry problem, or a "limiting" reagent problem?

Hint!

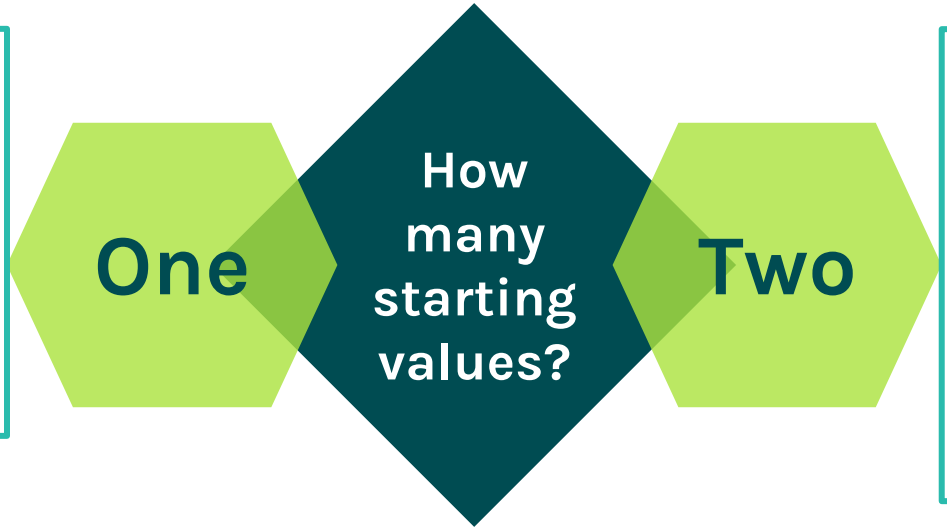
How many starting values?

- One starting value – “regular” stoich
- Two starting values – “limiting” stoich

Regular or Limiting?

Regular

If you react 25 g of hydrogen gas with oxygen gas, how many grams of water can you make?



Limiting

If you react 25 g of hydrogen gas with 30 g of oxygen gas, how many grams of water can you make?

Key terms:

Limiting Reagent

(LR)

The chemical you run out of too soon

Excess Reagent

(XS)

The chemical you have extra left over of

Usually 3 types of problems:

1. Find Limiting Reagent
2. Find Amounts Made
3. Find how much XS left over

ALL ABOUT MOLE RATIOS!

“The KEY to Stoichiometry!”

Dimensional Analysis, units, labeling, etc required!

Use mole ratios and dimensional analysis to compare...

What you *HAVE* *versus* What you *NEED*

Steps

1. Grams to moles
2. Have vs. need
3. Identify limiting
4. Stoich with limiting (*if asked*)
5. Find xs left (*if asked*)

If you reacted 150 g of K with 225 g of Br_2, how many g of KBr can be made? How much excess reagent is left?

$$2K + Br_2 \rightarrow 2KBr$$

1. Find Limiting Reagent
2. Find Amounts Made
3. Find how much XS left over

If you reacted 150 g of K with 225 g of Br_2, how many g of KBr can be made? How much excess reagent is left?

$$2K + Br_2 \rightarrow 2KBr$$

1

Find Limiting Reagent

If you reacted 150.0 g of K with 225 g of Br_2, how many g of KBr can be made? How much excess reagent is left?

$$2K + Br_2 \rightarrow 2KBr$$

$$\frac{150.0\text{ g K}}{} \left| \frac{1\text{ mol K}}{39.10\text{ g K}} \right. = 3.836\text{ mol K}$$

$$\frac{225\text{ g } Br_2}{} \left| \frac{1\text{ mol } Br_2}{159.8\text{ g } Br_2} \right. = 1.408\text{ mol } Br_2$$

Steps

1. **Grams to moles**
2. Have vs. need
3. Identify limiting
4. Stoich with limiting
5. Find xs left

If you reacted 150.0 g of K with 225 g of Br_2, how may g of KBr can be made? How much excess reagent is left?

$$2K + Br_2 \rightarrow 2KBr$$

HAVE:	**3.836** mol	**1.408** mol
NEED:		**1.918** mol

Steps
1. Grams to moles
2. **Have vs. need**
3. Identify limiting
4. Stoich with limiting
5. Find xs left

$$3.836 \text{ mol K} \times \frac{1 \text{ mol } Br_2}{2 \text{ mol K}}$$

= 1.918 mol Br_2 NEEDED to use up all the K you have!

Nice thing – it doesn't matter which starting value you try first! Cuts down the length of the problems/work a lot! You could have started with 1.408 moles of Br_2 instead!

If you reacted 150.0 g of K with 225 g of Br_2, how much KBr can be made? How much excess reagent is left?

Steps

1. Grams to moles
2. Have vs. need
3. **Identify limiting**
4. Stoich with limiting
5. Find xs left

$$2K + Br_2 \rightarrow 2KBr$$

HAVE:	**3.836** mol	**1.408** mol
NEED:		**1.918** mol

You don't have enough Br_2 – that makes it the "limiting regent" – you will run out of it first!

So K is your "excess reagent" – you will have some extra left over when done.

If you reacted 150 g of K with 225 g of Br_2, how many g of KBr can be made? How much excess reagent is left?

$$2K + Br_2 \rightarrow 2KBr$$

1. Find Limiting Reagent
2. Find Amounts Made
3. Find how much XS left over

If you reacted 150 g of K with 225 g of Br_2, how many g of KBr can be made? How much excess reagent is left?

$$2K + Br_2 \rightarrow 2KBr$$

If you reacted 150.0 g of K with 225 g of Br_2, how many g of KBr can be made? How much excess reagent is left?

$$2K + Br_2 \rightarrow 2KBr$$

Steps

1. Grams to moles
2. Have vs. need
3. Identify limiting
4. **Stoich with limiting**
5. Find xs left

$$\frac{225\text{ g } Br_2}{} \left| \frac{1\text{ mol } Br_2}{159.8\text{ g } Br_2} \right| \frac{2\text{ mol KBr}}{1\text{ mol } Br_2} \left| \frac{119\text{ g KBr}}{1\text{ mol KBr}} \right.$$

= 335.1 g KBr can be made

If you reacted 150.0 g of K with 225 g of Br_2, how many g of KBr can be made? How much excess reagent is left?

$$2K + Br_2 \rightarrow 2KBr$$

Steps

1. Grams to moles
2. Have vs. need
3. Identify limiting
4. **Stoich with limiting**
5. Find xs left

Or…realize you already did part of it right?!

$$\frac{1.408 \text{ mol } Br_2}{} \left| \frac{2 \text{ mol KBr}}{1 \text{ mol } Br_2} \right| \frac{119 \text{ g KBr}}{1 \text{ mol KBr}}$$

= 335.1 g KBr can be made

***Just be careful not to round too much early on if you want to use your earlier answer to continue doing your stoichiometry – you have to use your judgement**

If you reacted 150 g of K with 225 g of Br_2, how many g of KBr can be made? How much excess reagent is left?

$$2K + Br_2 \rightarrow 2KBr$$

1. Find Limiting Reagent
2. Find Amounts Made
3. Find how much XS left over

If you reacted 150 g of K with 225 g of Br_2, how many g of KBr can be made? How much excess reagent is left?

$$2K + Br_2 \rightarrow 2KBr$$

3

Find how much XS left over

If you reacted 150.0 g of K with 225 g of Br_2, how may g of KBr can be made? How much excess reagent is left?

$$2K + Br_2 \rightarrow 2KBr$$

HAVE:	**3.836** mol	**1.408** mol
NEED:	**2.816** mol	**1.918** mol

Br_2 is Limiting, so use it to find amount of XS used

Steps
1. Grams to moles
2. Have vs. need
3. Identify limiting
4. Stoich with limiting
5. **Find xs left**

$$\frac{1.408 \text{ mol } Br_2}{} \left| \begin{array}{l} 2 \text{ mol K} \\ \hline 1 \text{ mol } Br_2 \end{array} \right.$$

= 2.816 mol K used during the reaction

If you reacted 150.0 g of K with 225 g of Br_2, how many g of KBr can be made? How much excess reagent is left?

$$2K + Br_2 \rightarrow 2KBr$$

HAVE:	**3.836** mol	**1.408** mol
NEED:	**2.816** mol	**1.918** mol
LEFT:	**1.02** mol	

Now subtract to see what is left!

Steps

1. Grams to moles
2. Have vs. need
3. Identify limiting
4. Stoich with limiting
5. **Find xs left**

*** If it doesn't specify a unit (common) – then just leave in moles! Otherwise, just do more dimensional analysis to convert**

Let’s try one more!

If you reacted 13.2 g of Fe with 6.34 g of O_2, how many g of Fe_2O_3 can be made? How many grams of excess are left?

$$4Fe + 3O_2 \rightarrow 2Fe_2O_3$$

Steps

1. **Grams to moles**
2. Have vs. need
3. Identify limiting
4. Stoich with limiting
5. Find xs left

$$\frac{13.2\text{ g Fe}}{} \left| \frac{1\text{ mol Fe}}{55.85\text{ g Fe}} \right. = 0.236\text{ mol Fe}$$

$$\frac{6.34\text{ g } O_2}{} \left| \frac{1\text{ mol } O_2}{32\text{ g } O_2} \right. = 0.198\text{ mol } O_2$$

If you reacted 13.2 g of Fe with 6.34 g of O_2, how may g of Fe_2O_3 can be made? How many grams of excess are left?

$$4Fe + 3O_2 \rightarrow 2Fe_2O_3$$

HAVE:	**0.236** mol	**0.198** mol
NEED:		**0.177** mol

Steps
1. Grams to moles
2. **Have vs. need**
3. Identify limiting
4. Stoich with limiting
5. Find xs left

$$\frac{\textbf{0.236 mol Fe}}{} \quad \frac{\textbf{3 mol } O_2}{\textbf{4 mol Fe}}$$

= 0.177 mol O_2 NEEDED to use up all the Fe you have!

If you reacted 13.2 g of Fe with 6.34 g of O_2, how may g of Fe_2O_3 can be made? How many grams of excess are left?

$$4Fe + 3O_2 \rightarrow 2Fe_2O_3$$

HAVE:	**0.236** mol	**0.198** mol
NEED:		**0.177** mol

Steps
1. Grams to moles
2. Have vs. need
3. **Identify limiting**
4. Stoich with limiting
5. Find xs left

$$\frac{\textbf{0.236 mol Fe}}{\textbf{4 mol Fe}} \times \frac{\textbf{3 mol } O_2}{} = \textbf{0.177 mol } O_2 \textbf{ NEEDED}$$

to use up all the Fe you have!

You have more than enough O_2, so it is the excess reagent, so Fe is your limiting reagent!

If you reacted 13.2 g of Fe with 6.34 g of O_2, how may g of Fe_2O_3 can be made? How many grams of excess are left?

$$4Fe + 3O_2 \rightarrow 2Fe_2O_3$$

HAVE:	**0.236** mol	**0.198** mol
NEED:		**0.177** mol

Steps
1. Grams to moles
2. Have vs. need
3. Identify limiting
4. **Stoich w/ limiting**
5. Find xs left

$$\mathbf{0.236\ mol\ Fe} \times \frac{\mathbf{2\ mol\ Fe_2O_3}}{\mathbf{4\ mol\ Fe}} \times \frac{\mathbf{159.69\ g\ Fe_2O_3}}{\mathbf{1\ mol\ Fe_2O_3}}$$

= 18.84 g Fe_2O_3 can be made

If you reacted 13.2 g of Fe with 6.34 g of O_2, how may g of Fe_2O_3 can be made? How many grams of excess are left?

$$4Fe + 3O_2 \rightarrow 2Fe_2O_3$$

HAVE:	**0.236** mol	**0.198** mol
NEED:		**0.177** mol
LEFT:		**0.021** mol

Steps
1. Grams to moles
2. Have vs. need
3. Identify limiting
4. Stoich w/ limiting
5. **Find xs left**

Now subtract to see what is left!

$$\frac{0.021 \text{ mol } O_2}{} \times \frac{32 \text{ g } O_2}{1 \text{ mol } O_2} = 0.672 \text{ g } O_2 \text{ left over}$$

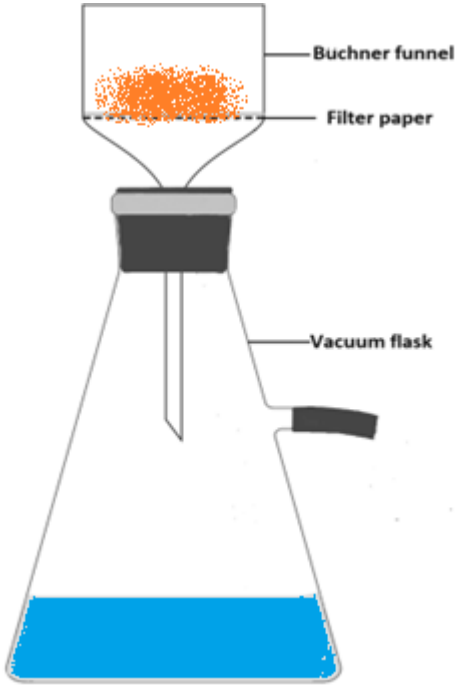
Limiting Reagent Lab

Calcium Chloride + Sodium Carbonate

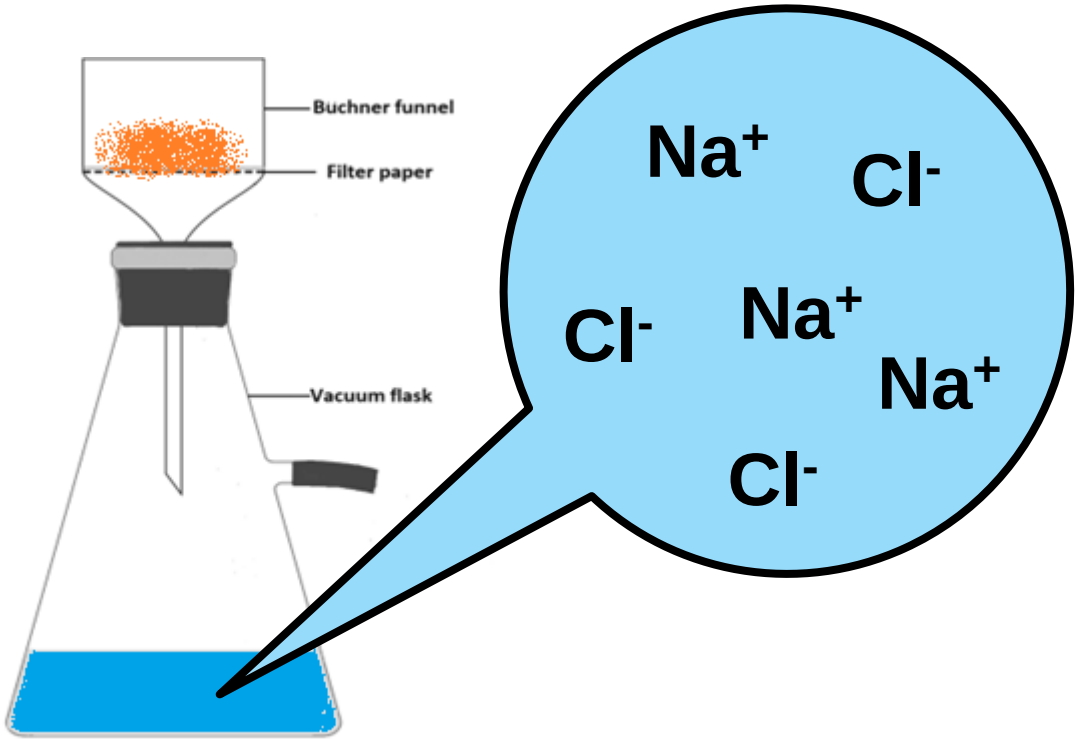
$CaCl_2$ + Na_2CO_3 → $CaCO_3$ + 2 NaCl

Insoluble (s) ***precipitate***

Soluble (aq) ***filtrate***



Calcium Chloride + Sodium Carbonate



NaCl

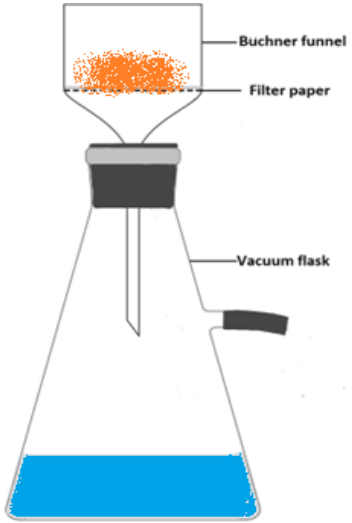
Soluble

(aq)

filtrate

Can't really weigh the NaCl product when it is in the aqueous filtrate. Need to somehow remove the water so the ions go back together leaving solid NaCl...how can we remove the water???

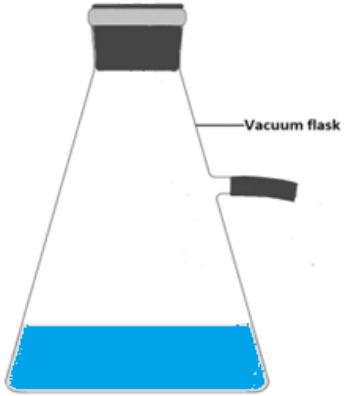
Boil and/or Evaporate the water away!



→

NaCl (aq)

filtrate



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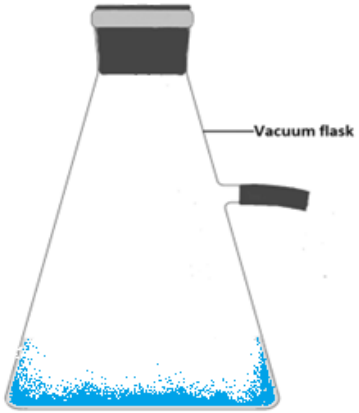
NaCl (s)

Now it is solid salt left over!



Vacuum Filtration

https://youtu.be/ZwER7qEuRow

YouTube Link to Presentation

https://youtu.be/iUjL9AVeSnU