

$$3 \text{ mole Al} = 3 \text{ mole NH}_4\text{CO}_3$$

$$3 \text{ mole Al} = 6 \text{ mole H}_2\text{O}$$

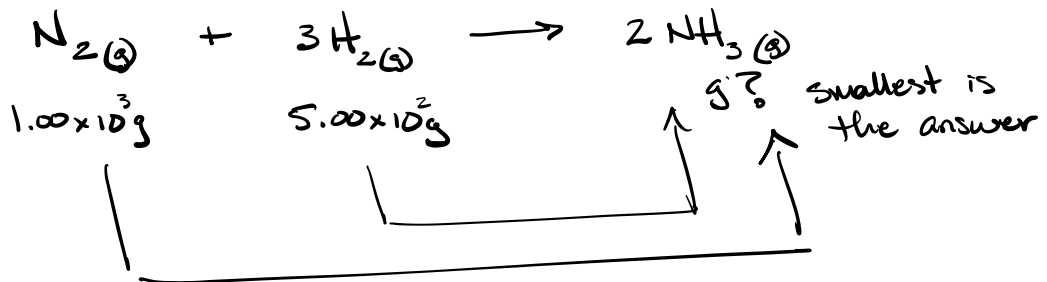
Limiting Reagent



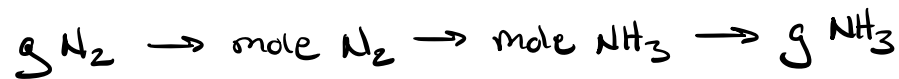
Runs out & Limits the Products

$$3 \text{ wheels} \times \frac{1 \text{ bike}}{2 \text{ wheels}} = \boxed{1 \text{ bikes}}$$

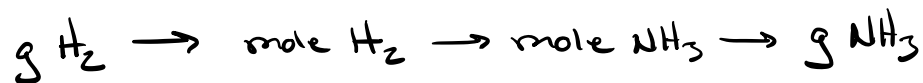
$$7 \text{ frames} \times \frac{1 \text{ bike}}{1 \text{ frame}} = 7 \text{ bikes}$$



### Road Map A



### Road Map B



### Road Map A



### Molar Mass



$$2 \times 14.01 \text{ g} = 28.02 \text{ g/mole N}_2$$



$$14.01 \text{ g} + 3 \times 1.008 = \begin{array}{r} 14.01 \\ 3.024 \\ \hline 17.034 \end{array} \quad (17.03 \text{ g/mole NH}_3)$$



$$1.00 \times 10^3 \text{ g } \text{NH}_3 \times \frac{1 \text{ mole } \text{NH}_3}{17.03 \text{ g } \text{NH}_3} \times \frac{2 \text{ mole } \text{NH}_3}{1 \text{ mole } \text{NH}_3} \times \frac{17.03 \text{ g } \text{NH}_3}{1 \text{ mole } \text{NH}_3} = 1234.832 \text{ g } \text{NH}_3$$

**= 1230 g NH<sub>3</sub>**

All 14 possible Compounds

- Na<sub>2</sub>SO<sub>4</sub> Na<sub>3</sub>PO<sub>4</sub> NaNO<sub>3</sub> NaOH NaCl Na<sub>2</sub>CO<sub>3</sub> AlCl<sub>3</sub>  
 NH<sub>4</sub>Cl CaCl<sub>2</sub> CuSO<sub>4</sub> FeCl<sub>3</sub> Pb(NO<sub>3</sub>)<sub>2</sub> KI AgNO<sub>3</sub>

↓ CaCl<sub>2</sub>

Clear & Colorless NO Rxn	$M^+ N M^- + CaCl_2 \rightarrow Ca N M^- + M^+ Cl^-$	Precipitate PPT
	$F^- \quad Pb^{2+}$ $SO_4^{2-} \quad Ag^+$ $OH^-$ $CO_3^{2-}$ $PO_4^{3-}$	
<p style="text-align: center; border-bottom: 1px solid red; margin-bottom: 5px;">No Rxn</p> <p>NaNO<sub>3</sub> KI          NaCl          AlCl<sub>3</sub>          NH<sub>4</sub>Cl          CaCl<sub>2</sub>          FeCl<sub>3</sub></p>		<p style="text-align: center; border-bottom: 1px solid red; margin-bottom: 5px;">PPT</p> <p><del>Na<sub>2</sub>SO<sub>4</sub> Pb(NO<sub>3</sub>)<sub>2</sub></del>  <del>Na<sub>3</sub>PO<sub>4</sub> AgNO<sub>3</sub></del>  <del>NaOH</del>  <del>Na<sub>2</sub>CO<sub>3</sub></del>  <del>CuSO<sub>4</sub></del></p>

new test  
↓

no Rxn

PPT

KI  
NaNO<sub>3</sub>  
NaCl  
NH<sub>4</sub>Cl

CaCl<sub>2</sub>  
FeCl<sub>3</sub>  
AlCl<sub>3</sub>

Group 1A Cation  
& NH<sub>4</sub><sup>+</sup>

other

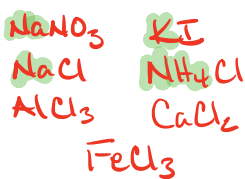
\* Pick a cation that  
will not form ppt with  
any anion  
⇒ Group 1A

\* Pick an anion  
that will form ppt  
with Ca<sup>2+</sup>, Fe<sup>3+</sup>, Al<sup>3+</sup>  
⇒ OH<sup>-</sup>, CO<sub>3</sub><sup>2-</sup>, PO<sub>4</sub><sup>3-</sup>

NaOH, Na<sub>2</sub>CO<sub>3</sub>, Na<sub>3</sub>PO<sub>4</sub>  
would be good tests

Possible Test A

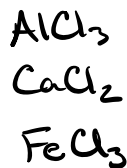
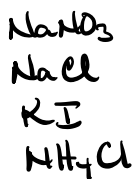
one possible sort by Cation



By Cation

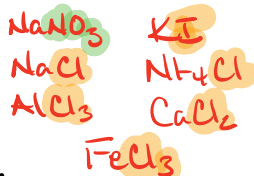
Other metals

Group IA,  $\text{NH}_4^+$



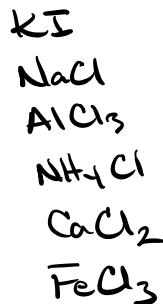
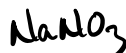
Possible Test B

one possible sort by Anion



always soluble

usually soluble



# Possible Tests from A

Test Compound + unk X

Clear & Colorless  
No Rxn

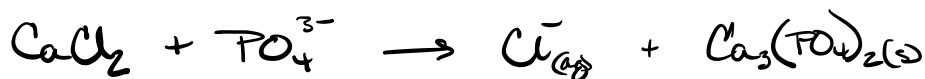
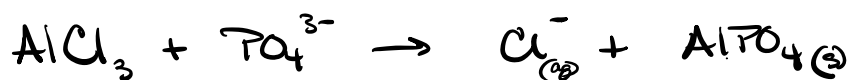
$\text{NaNO}_3$   
 $\text{NaCl}$   
 $\text{KI}$   
 $\text{NH}_4\text{Cl}$

Need an anion that will not PPT with  $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{NH}_4^+$

PPT

$\text{AlCl}_3$   
 $\text{CaCl}_2$   
 $\text{FeCl}_3$

Need an anion that will PPT w/  $\text{Al}^{3+}$ ,  $\text{Ca}^{2+}$ ,  $\text{Fe}^{3+}$   
 $\Rightarrow \text{OH}^-$ ,  $\text{CO}_3^{2-}$ ,  $\text{PO}_4^{3-}$



Unknown is one of these 7

$\text{NaNO}_3$   $\text{KI}$   
 $\text{NaCl}$   $\text{NH}_4\text{Cl}$   
 $\text{AlCl}_3$   $\text{CaCl}_2$   
 $\text{FeCl}_3$

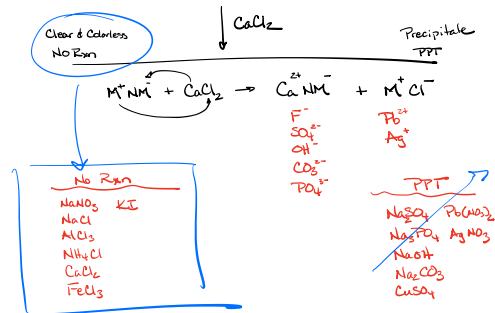
$\text{CuSO}_4$



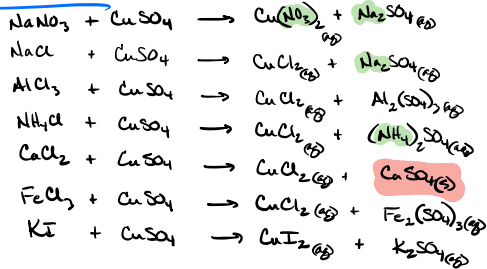
All 14 possible Compounds

$\text{Na}_2\text{SO}_4$   $\text{Na}_3\text{PO}_4$   $\text{NaNO}_3$   $\text{NaOH}$   $\text{NaCl}$   $\text{Na}_2\text{CO}_3$   $\text{AlCl}_3$

$\text{NH}_4\text{Cl}$   $\text{CaCl}_2$   $\text{CuSO}_4$   $\text{FeCl}_3$   $\text{Pb}(\text{NO}_3)_2$   $\text{KI}$   $\text{AgNO}_3$



use solubility Rules

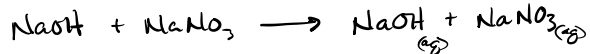


Harder Choice  
but better choice ←  
Sort by Group 1A &  $\text{NH}_4$

Sort by  $\text{Cl}^-$

PPT	$\text{Ag}^+$	no Rxn
		$\text{NaNO}_3$
		$\text{NaCl}$
		$\text{AlCl}_3$
		$\text{NH}_4\text{Cl}$
		$\text{FeCl}_3$
		$\text{KI}$

no PPT	$\text{OH}^-$ or $\text{CO}_3^{2-}$ or $\text{PO}_4^{3-}$
$\text{NaNO}_3$	$\text{AlCl}_3$
$\text{NaCl}$	$\text{FeCl}_3$
$\text{KI}$	
$\text{NH}_4\text{Cl}$	





$\text{CuSO}_4$  poor choice

$\text{Cu}^{2+}$   $\text{OH}^-$ ,  $\text{CO}_3^{2-}$ ,  $\text{PO}_4^{3-}$   
 $\text{SO}_4^{2-}$   $\text{Pb}^{2+}$ ,  $\text{Ca}^{2+}$ ,  $\text{Ba}^{2+}$  } Both Cation & anion  
FPT  $\Rightarrow$  hard to analyse

$\text{NaOH}$  good choice

$\text{Na}^+$  always soluble

only one half ppt  
So easy to analyse

$\text{OH}^-$  usually insoluble

focus on one part  
only