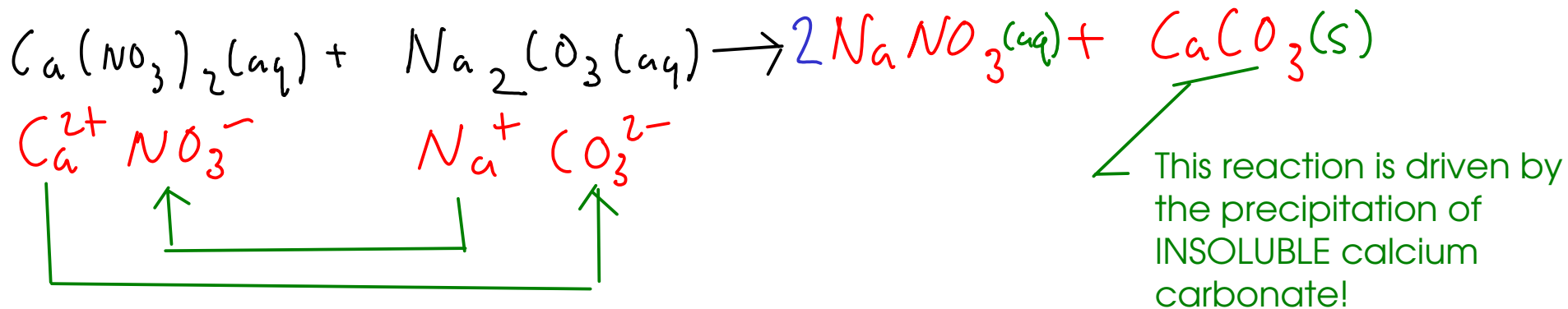
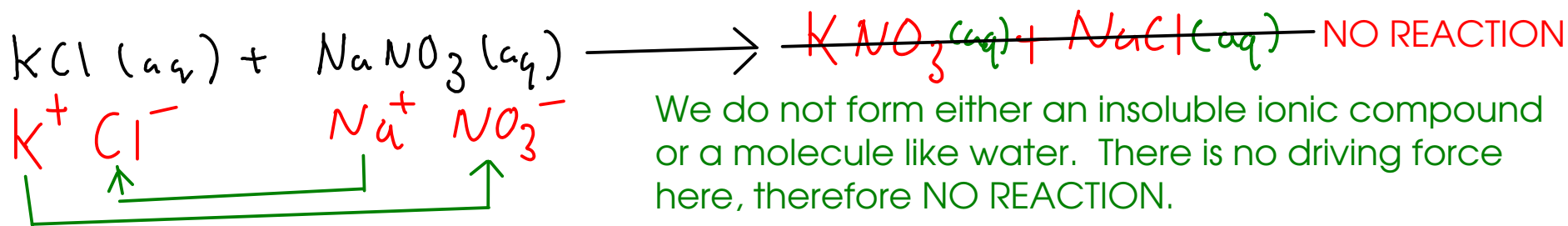
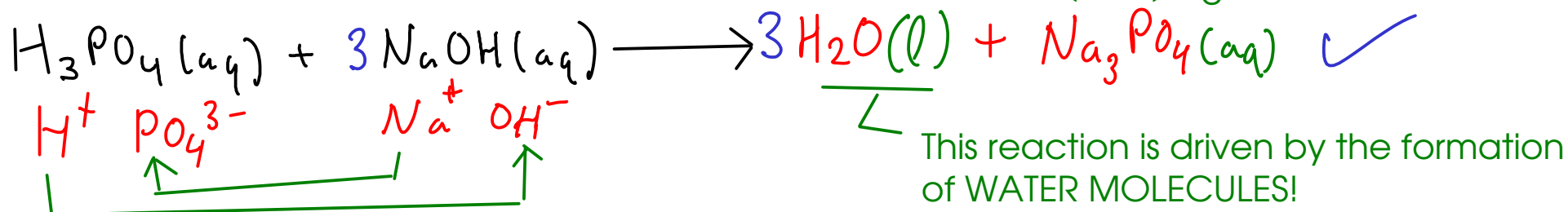
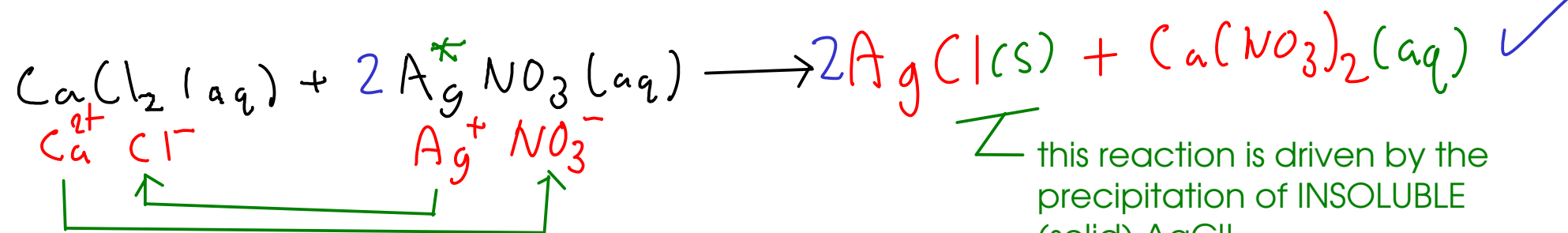


* Transition metals DO NOT change their charge in exchange reactions!

A few examples of precipitation and acid/base:

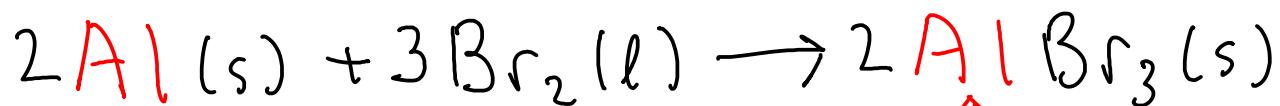


OXIDATION / REDUCTION CHEMISTRY

- Precipitation reactions involve ions pairing up, but the ions themselves are not formed in precipitation reactions. Precipitation reactions (and quite a few others) start with pre-existing ions.

... but ions have to be produced somehow - through a chemistry that involves the transfer of electrons.

- OXIDATION/REDUCTION chemistry ("REDOX" chemistry) involves transfer of electrons and can make ions.



↑
Elemental,
metallic
aluminum.
Uncharged!

↑
Aluminum
cation



These are called
"half-reactions"



electron

oxidation: loss
of electrons

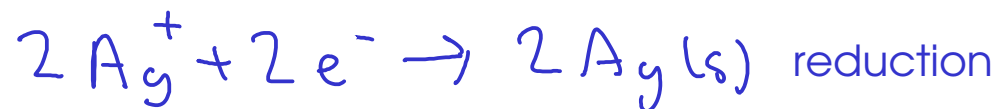
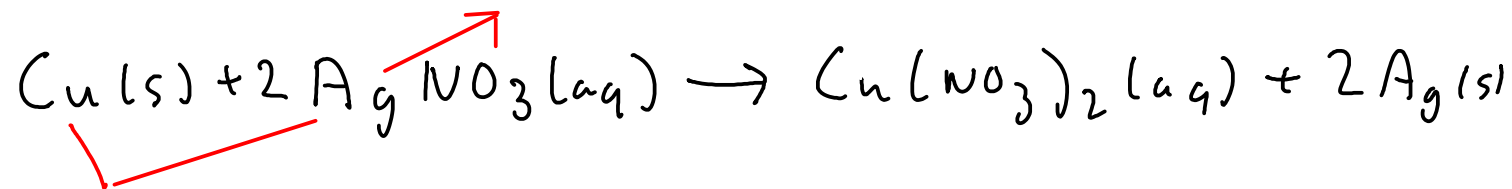


reduction: gain of
electrons

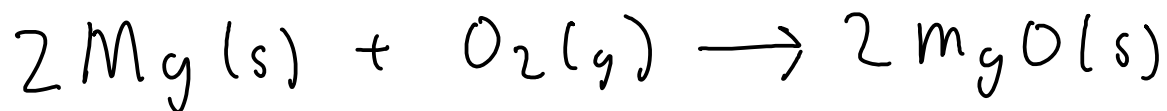
- oxidation and reduction always occur together. In other words, we can't just make free electrons using oxidation without giving them somewhere to go.

- Many of the types of reactions that you might have heard of before are actually redox reactions!

- SINGLE REPLACEMENT reactions

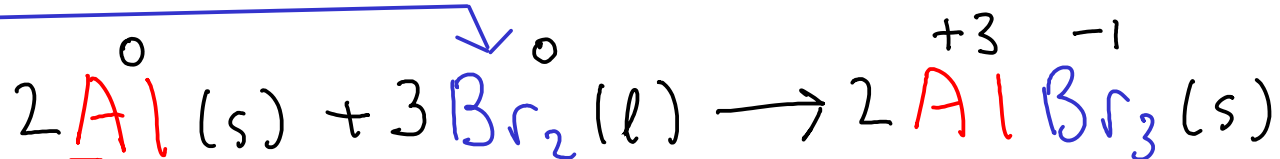


- COMBUSTION reactions (burning)



REDOX LANGUAGE*"oxidizer"*

- "Oxidation" is loss of electrons, but an OXIDIZING AGENT is something that causes ANOTHER substance to lose electrons. An oxidizing agent is itself reduced during a redox reaction.
- "Reduction" is gain of electrons, but a REDUCING AGENT is something that causes ANOTHER substance to gain electrons. Reducing agents are themselves oxidized during a redox reaction.



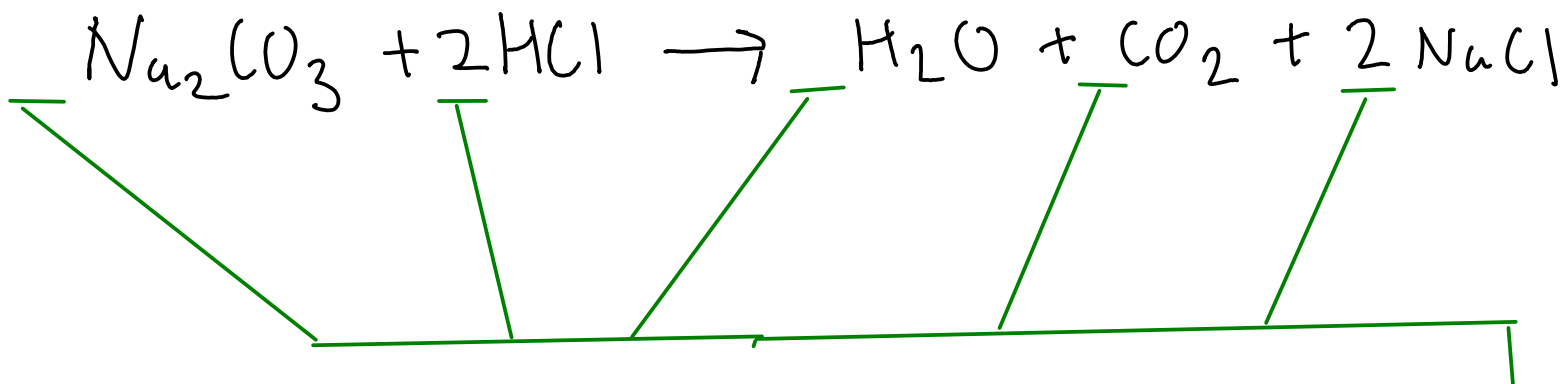
Aluminum is OXIDIZED during this process. We say that metallic aluminum is a REDUCING AGENT!

Bromine is REDUCED during this process. We say that bromine is an OXIDIZING AGENT!

* Strong oxidizers (oxidizing agents) can cause spontaneous fires if placed into contact with combustibles (safety issue!).

* Reactive metals tend to be REDUCING AGENTS, while oxygen-rich ions like NITRATES tend to be OXIDIZING AGENTS. HALOGENS (Group VIIA) also tend to be OXIDIZING AGENTS

CHEMICAL CALCULATIONS - RELATING MASS AND ATOMS

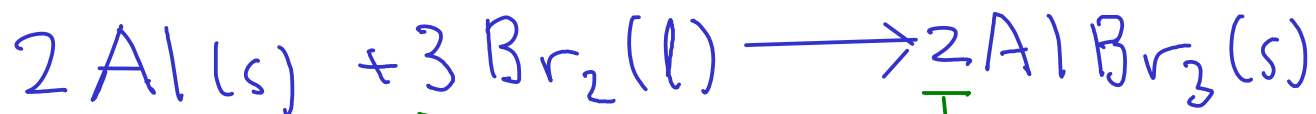


Chemical equations are written
and balanced in terms of
ATOMS and MOLECULES

- While chemical equations are written in terms of ATOMS and MOLECULES, that's NOT how we often measure substances in lab!
- measurements are usually MASS (and sometimes VOLUME), NOT number of atoms or molecules!

CHEMICAL CALCULATIONS CONTINUED: REACTIONS

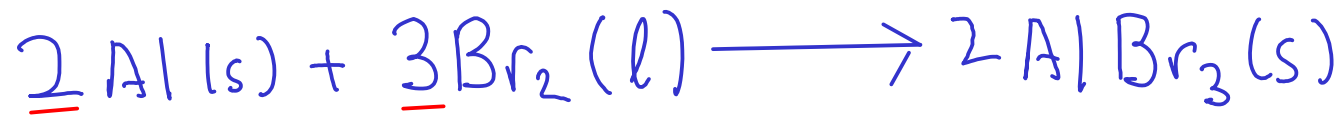
- Chemical reactions proceed on an ATOMIC basis, NOT a mass basis!
- To calculate with chemical reactions (i.e. use chemical equations), we need everything in terms of ATOMS ... which means MOLES of atoms



coefficients are in terms of atoms and molecules!



- To do chemical calculations, we need to:
 - Relate the amount of substance we know (mass or volume) to a number of moles
 - Relate the moles of one substance to the moles of another using the equation
 - Convert the moles of the new substance to mass or volume as desired



* Given that we have 25.0 g of liquid bromine, how many grams of aluminum would we need to react away all of the bromine?

① Convert grams of bromine to moles: Need formula weight $\text{Br}_2 : \frac{2 \times 79.90}{159.80}$

$$159.80 \text{ g Br}_2 = \text{mol Br}_2$$

$$25.0 \text{ g Br}_2 \times \frac{\text{mol Br}_2}{159.80 \text{ g Br}_2} = 0.15645 \text{ mol Br}_2$$

② Use the chemical equation to relate moles of bromine to moles of aluminum

$$2 \text{ mol Al} = 3 \text{ mol Br}_2$$

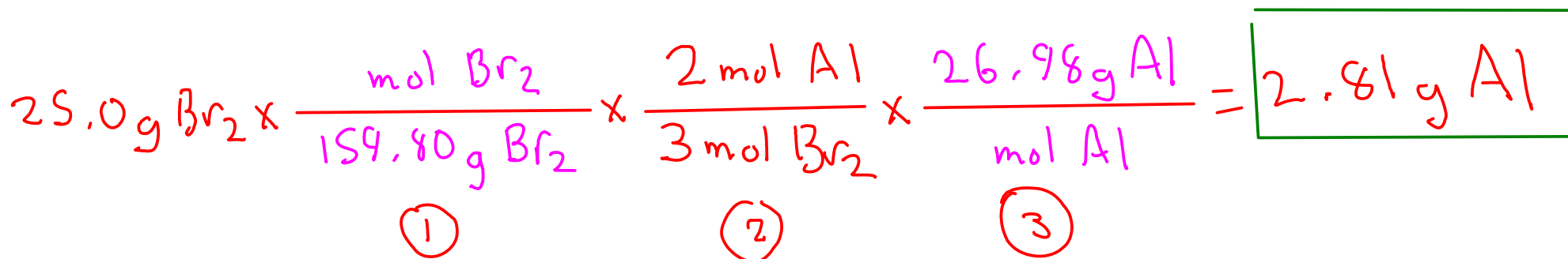
$$0.15645 \text{ mol Br}_2 \times \frac{2 \text{ mol Al}}{3 \text{ mol Br}_2} = 0.10430 \text{ mol Al}$$

③ Convert moles aluminum to mass: Need formula weight $\text{Al} : 26.98$

$$26.98 \text{ g Al} = \text{mol Al}$$

$$0.10430 \text{ mol Al} \times \frac{26.98 \text{ g Al}}{\text{mol Al}} = \boxed{2.81 \text{ g Al}}$$

You can combine all three steps on one line if you like!

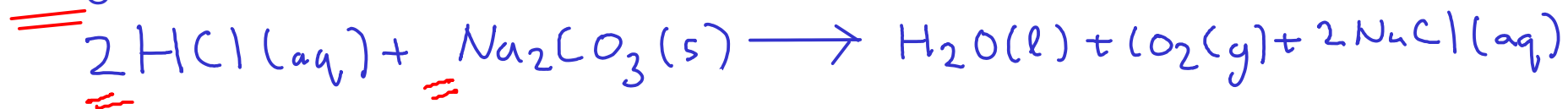


Things we can do:

If we have and we need ...	Use ...
MASS	MOLES	FORMULA WEIGHT
SOLUTION VOLUME	MOLES	MOLAR CONCENTRATION (MOLARITY)
MOLES OF A	MOLES OF B	BALANCED CHEMICAL EQUATION

Example:

How many milliliters of 6.00M hydrochloric acid is needed to completely react with 25.0 g of sodium carbonate?



-
- 1 - Convert 25.0 grams of sodium carbonate to moles. Use FORMUAL WEIGHT.
 - 2 - Convert moles sodium carbonate to moles HCl. Use CHEMICAL EQUATION.
 - 3 - Convert moles HCl to volume HCl solution. Use MOLARITY (6.00 M).
-

$$\textcircled{1} \text{Na}_2\text{CO}_3: \begin{array}{l} \text{Na} - 2 \times 22.99 \\ \text{C} - 1 \times 12.01 \\ \text{O} - 3 \times 16.00 \\ \hline 105.99 \text{g Na}_2\text{CO}_3 = \text{mol Na}_2\text{CO}_3 \end{array}$$

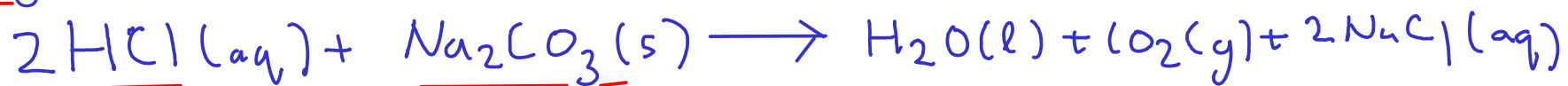
$$25.0 \text{g Na}_2\text{CO}_3 \times \frac{\text{mol Na}_2\text{CO}_3}{105.99 \text{g Na}_2\text{CO}_3} = 0.2358713086 \text{mol Na}_2\text{CO}_3$$

$$\textcircled{2} 2 \text{mol HCl} = \text{mol Na}_2\text{CO}_3$$

$$0.2358713086 \text{mol Na}_2\text{CO}_3 \times \frac{2 \text{mol HCl}}{\text{mol Na}_2\text{CO}_3} = 0.4717426172 \text{mol HCl}$$

Example:

How many milliliters of 6.00M hydrochloric acid is needed to completely react with 25.0 g of sodium carbonate?



- 1 - Convert 25.0 grams of sodium carbonate to moles. Use FORMUAL WEIGHT.
- 2 - Convert moles sodium carbonate to moles HCl. Use CHEMICAL EQUATION.
- 3 - Convert moles HCl to volume HCl solution. Use MOLARITY (6.00 M).

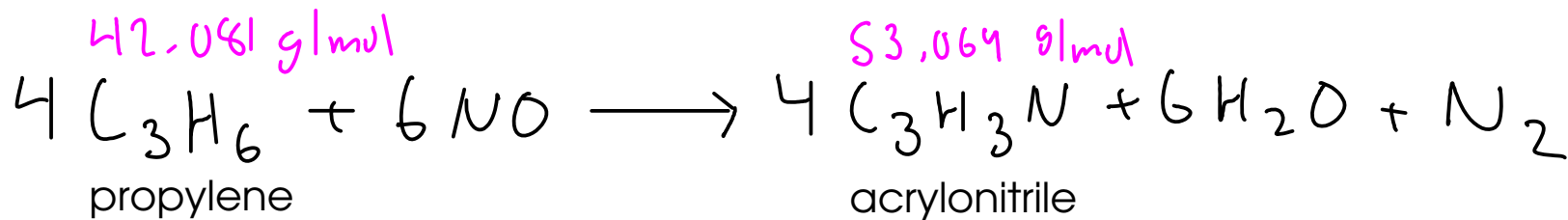
$$\textcircled{3} \quad 6.00 \text{ mol HCl} = \text{L}$$

$$0.4717426172 \text{ mol HCl} \times \frac{\text{L}}{6.00 \text{ mol HCl}} = 0.0786237695 \text{ L HCl solution}$$

We have the volume (0.0786 L), but we need to convert to mL to fully finish the problem.

$$\text{mL} = 10^{-3} \text{ L}$$

$$0.0786237695 \text{ L} \times \frac{\text{mL}}{10^{-3} \text{ L}} = \boxed{78.6 \text{ mL of } 6.00 \text{ M HCl}}$$



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

- 1 - Convert 651 grams of propylene to moles. Use FORMULA WEIGHT.
- 2 - Convert moles propylene to moles acrylonitrile. Use CHEMICAL EQUATION.
- 3 - Convert moles acrylonitrile to grams acrylonitrile. Use FORMULA WEIGHT.

$$\textcircled{1} 42.081 \text{ g C}_3\text{H}_6 = \text{mol C}_3\text{H}_6 \quad \textcircled{2} 4 \text{ mol C}_3\text{H}_6 = 4 \text{ mol C}_3\text{H}_3\text{N}$$

$$\textcircled{3} 53.064 \text{ g C}_3\text{H}_3\text{N} = \text{mol C}_3\text{H}_3\text{N}$$

$$651 \text{ g C}_3\text{H}_6 \times \frac{\text{mol C}_3\text{H}_6}{42.081 \text{ g C}_3\text{H}_6} \times \frac{4 \text{ mol C}_3\text{H}_3\text{N}}{4 \text{ mol C}_3\text{H}_6} \times \frac{53.064 \text{ g C}_3\text{H}_3\text{N}}{\text{mol C}_3\text{H}_3\text{N}} = \boxed{821 \text{ g C}_3\text{H}_3\text{N}}$$