N26 – THE MOLE RATIO AND STOICHIOMETRY

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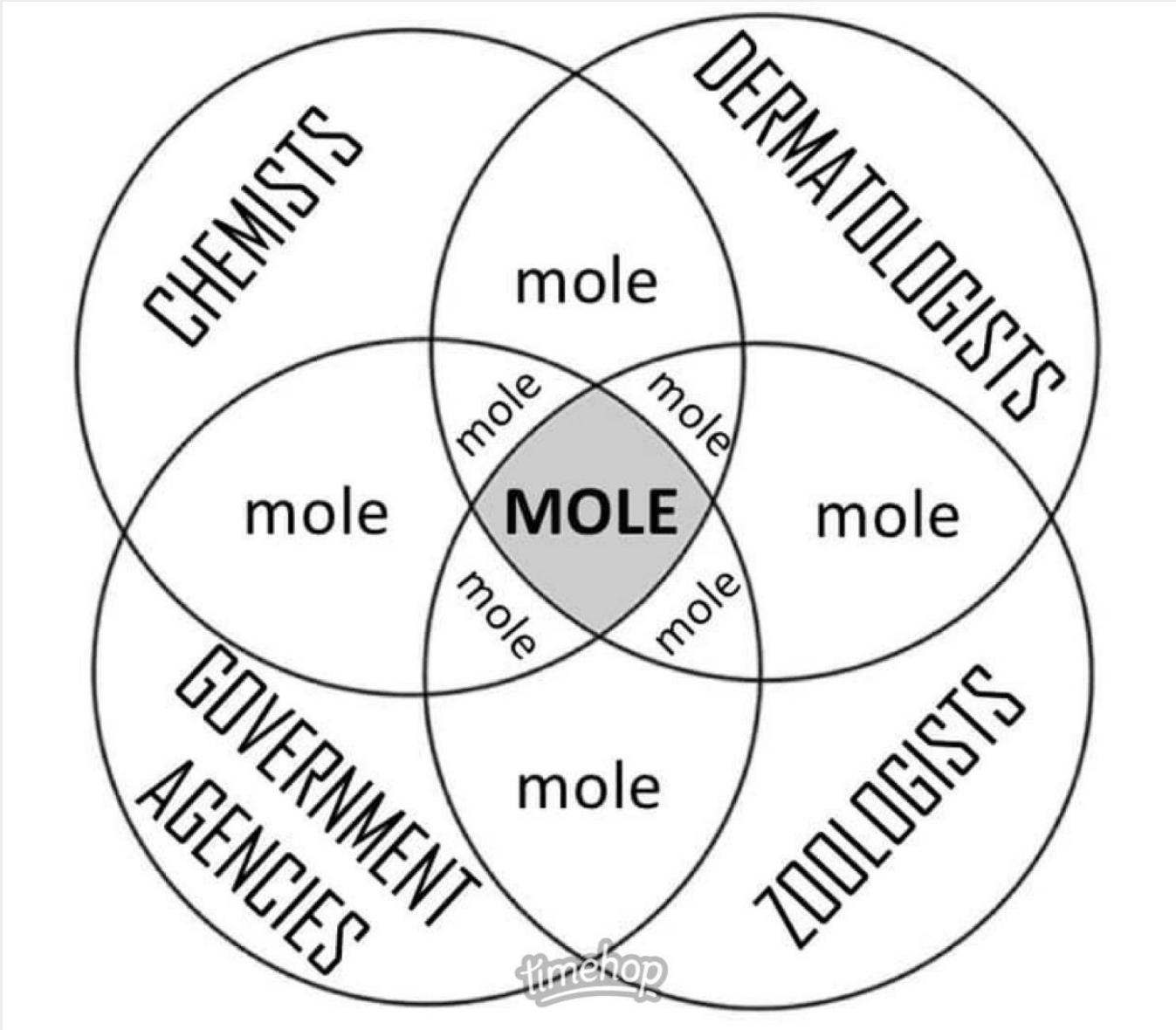
Target: I can use a balanced equation to determine the "mole ratio" between various molecules in a reaction, so that I can perform "stoichiometry" where I convert from an amount of one molecule to an amount of a totally different molecule.

Link to YouTube Presentation: https://youtu.be/FjNpLz_Wxt4


CHEMISTS
DERMATOLOGISTS
GOVERNMENT AGENCIES
ZOOLOGISTS
mole
mole
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MOLE
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timehop

Stoichiometry

Calculating the amounts of reactants and/or products that are involved in a reaction

How much do I have, need, or make?

Stoichiometry

We need a balanced equation before we can do stoichiometry.

The coefficients in the balanced equation gives insight into how much of each thing we need or make

Balanced Equation Coefficients

$$2H_2 + O_2 \rightarrow 2H_2O$$

Can be thought of as how many molecules are needed

- 2 hydrogen molecules
- 1 oxygen molecule
- 2 water molecules

Balanced Equation Coefficients

$2H_2 + O_2 \rightarrow 2H_2O$

Can <u>ALSO</u> be thought of as

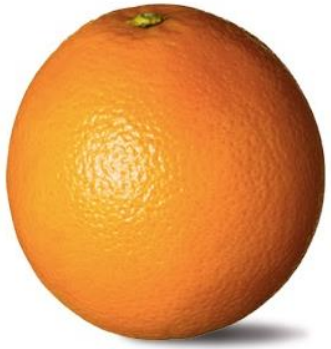
how many <u>MOLES</u> of molecules

- 2 ***moles*** hydrogen molecules
- 1 ***moles*** oxygen molecule
- 2 ***moles*** water molecules

Why use Molar Coefficients and not Grams for our calculations?

Allows us to compare "apples to apples"

Grams of molecule A



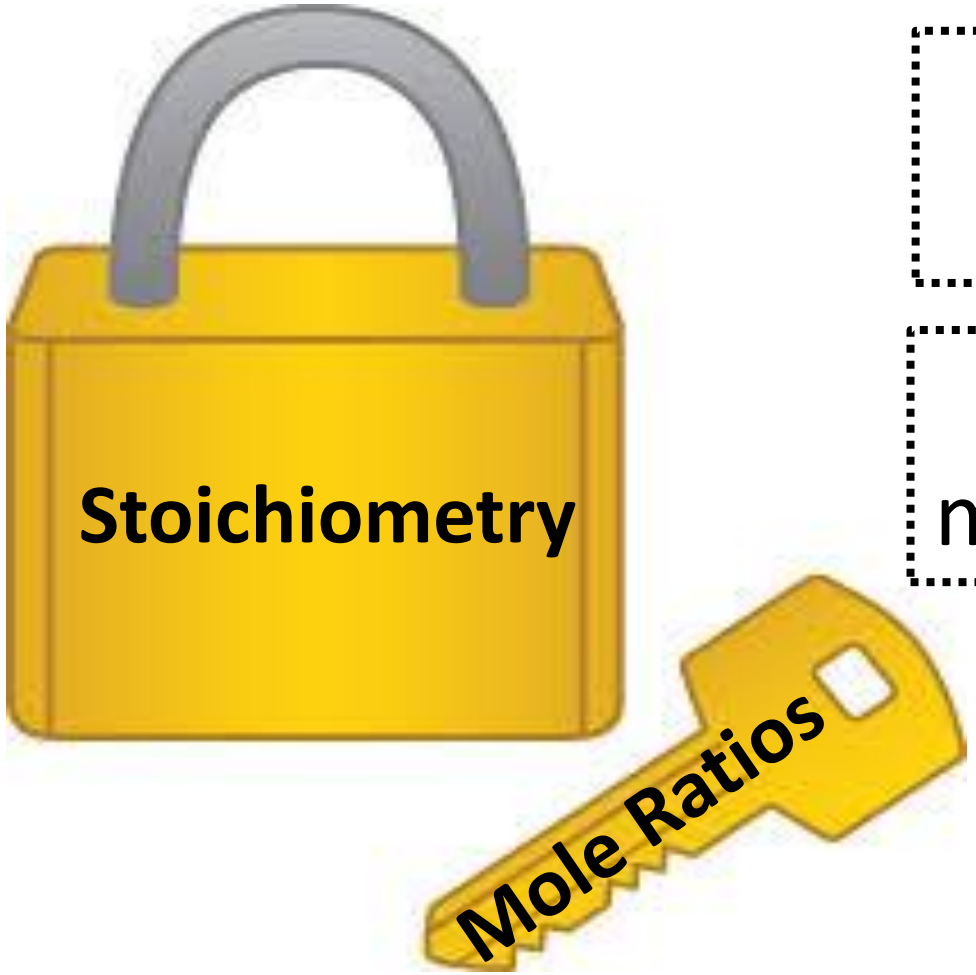
Grams of molecule B

MOLES of molecule A

MOLES of molecule B

Mole Ratios

The "KEY" to stoichiometry!

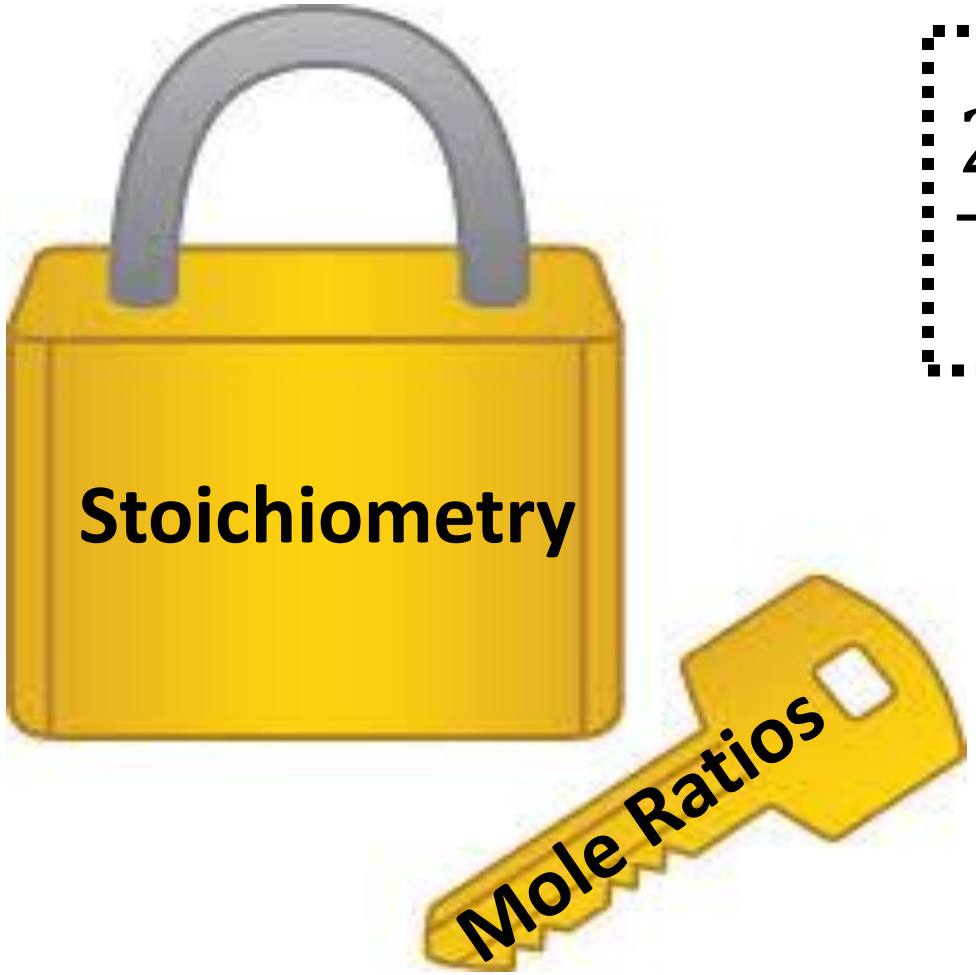


If I have 3 moles of this, how many moles of that do I have?

If I have 2 moles of this, how many moles of that can I make?

Mole Ratios

$$2H_2 + O_2 \rightarrow 2H_2O$$



$$\frac{2\ moles\ H_2}{1\ mole\ O_2}$$

$$\frac{2\ moles\ H_2}{2\ moles\ H_2O}$$

$$\frac{1\ mole\ O_2}{2\ moles\ H_2O}$$

Mole Ratios

You can flip all mole ratios

$$\frac{2\ moles\ H_2}{1\ mole\ O_2}$$

$$\frac{1\ mole\ O_2}{2\ moles\ H_2}$$

$$\frac{2\ moles\ H_2}{2\ moles\ H_2O}$$

$$\frac{2\ moles\ H_2O}{2\ moles\ H_2}$$

$$\frac{1\ mole\ O_2}{2\ moles\ H_2O}$$

$$\frac{2\ moles\ H_2O}{1\ mole\ O_2}$$

Mole Ratios

Write all the mole ratios

$$2C_2H_2 + 5O_2 \rightarrow 2H_2O + 4CO_2$$

$$\frac{2\ mole\ C_2H_2}{5\ moles\ O_2}$$

$$\frac{2\ mole\ C_2H_2}{2\ moles\ H_2O}$$

$$\frac{2\ mole\ C_2H_2}{4\ moles\ CO_2}$$

$$\frac{5\ moles\ O_2}{2\ moles\ H_2O}$$

$$\frac{5\ moles\ O_2}{4\ moles\ CO_2}$$

$$\frac{2\ moles\ H_2O}{4\ moles\ CO_2}$$

Mole Ratios $2C_2H_2 + 5O_2 \rightarrow 2H_2O + 4CO_2$

Can be used as conversion factors!

How many moles of carbon dioxide can be made from 19.46 moles of oxygen gas?

$$\frac{19.46 \text{ moles } O_2}{} \left| \frac{4 \text{ moles } CO_2}{5 \text{ moles } O_2} \right. = 15.57 \text{ moles } CO_2$$

Mole Ratios $2C_2H_2 + 5O_2 \rightarrow 2H_2O + 4CO_2$

Can be used as conversion factors!

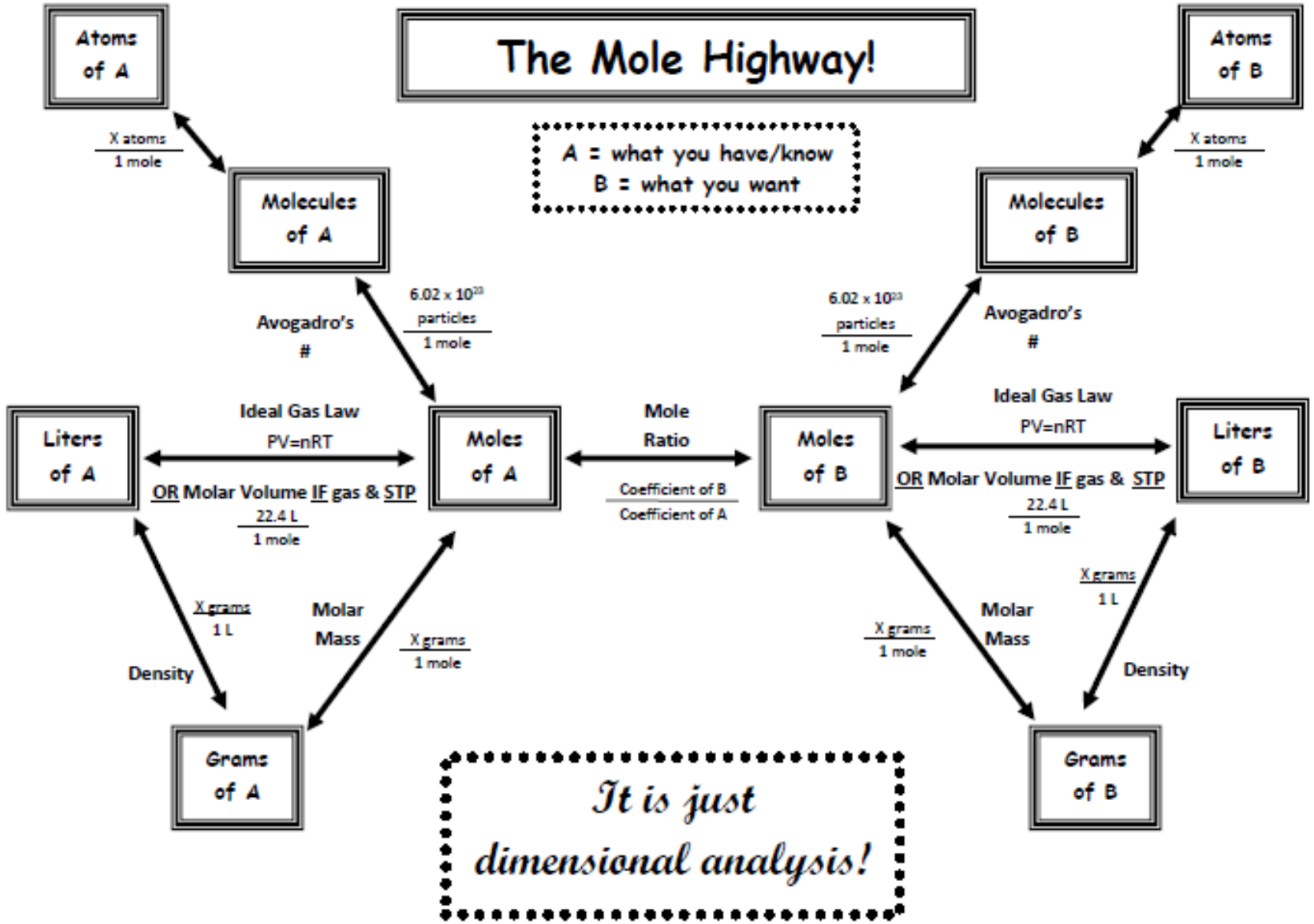
If you made 13.42 moles of water, how many moles of oxygen gas did you start with?

$$\frac{13.42 \text{ moles } H_2O}{} \times \frac{5 \text{ moles } O_2}{2 \text{ moles } H_2O} = 33.55 \text{ moles } O_2$$

What if you don't want your answer in moles? What if you weren't given moles?

THE MOLE HIGHWAY

All roads lead to the mole!


The Mole Highway!
A = what you have/know
B = what you want
Atoms of A
X atoms / 1 mole
Molecules of A
Avogadro's #
6.02 x 10^23 particles / 1 mole
Liters of A
Ideal Gas Law
PV=nRT
OR Molar Volume IF gas & STP
22.4 L / 1 mole
Moles of A
Mole Ratio
Coefficient of B / Coefficient of A
Moles of B
Density
X grams / 1 L
Molar Mass
X grams / 1 mole
Grams of A
Atoms of B
Molecules of B
Liters of B
Grams of B
It is just dimensional analysis!

Guided Stoichiometry Practice Problems

Q #1

$$N_2 + 3H_2 \rightarrow 2NH_3$$

A B

54 grams N_2 → ? moles NH_3

Pathway: *grams A → moles A → moles B*

Molar mass of A

X g A

1 mole A

Mole Ratio

moles B

moles A

Q #1

$$N_2 + 3H_2 \rightarrow 2NH_3$$

A B

54 grams N_2 → ? moles NH_3

Pathway: *grams A → moles A → moles B*

Molar mass of A

X g A

1 mole A

Mole Ratio

moles B

moles A

Q #1

$$N_2 + 3H_2 \rightarrow 2NH_3$$

A B

54 grams N_2 → ? moles NH_3

$$\frac{54\ g\ N_2}{} \left| \frac{1\ mole\ N_2}{28.01\ g\ N_2} \right| \frac{2\ mole\ NH_3}{1\ mole\ N_2}$$

= 3.9 moles NH_3

Q #2

$N_2 + 3H_2 \rightarrow 2NH_3$

B A

75 grams NH_3 → ? g H_2

Pathway:

grams A → moles A → moles B → grams B

Molar mass of A

X g A

1 mole A

Mole Ratio

moles B

moles A

Molar mass of B

X g B

1 mole B

Q #2

$$N_2 + 3H_2 \rightarrow 2NH_3$$

B A

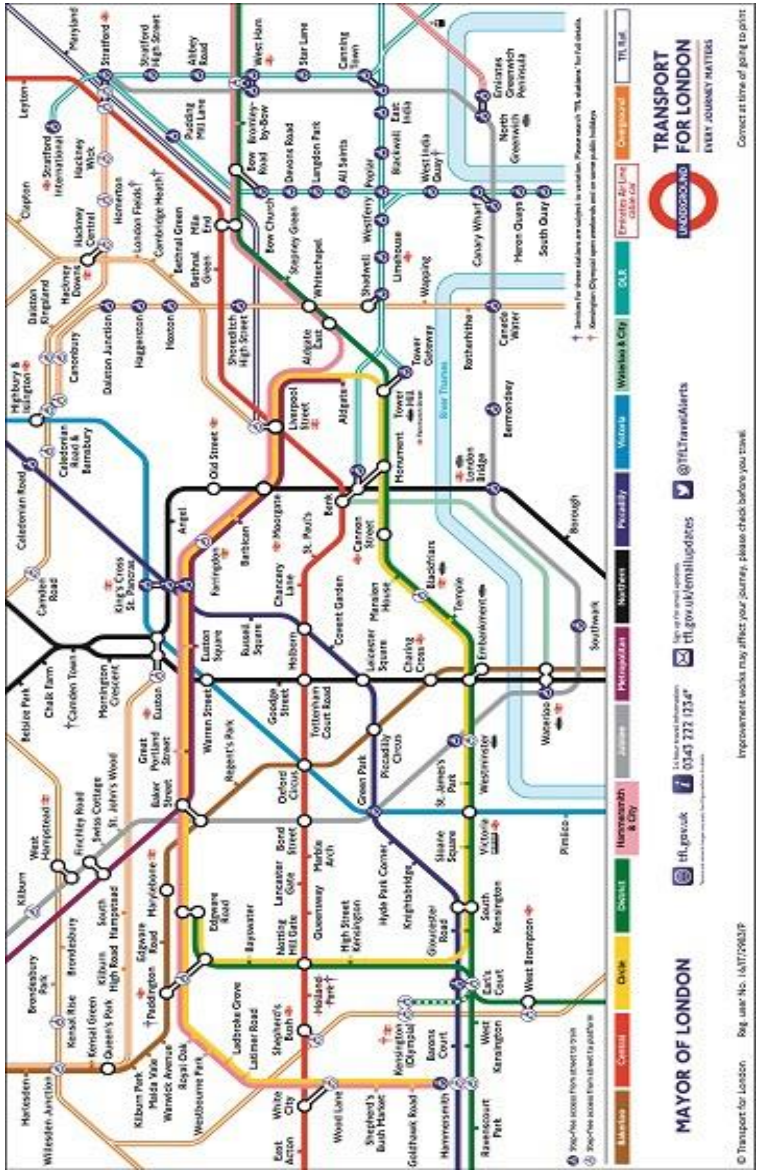
75 grams NH_3 → ? g H_2

75 g NH_3	1 mole NH_3	3 mole H_2	2.02 g H_2
	17.03 g NH_3	2 mole NH_3	1 mole H_2

= 13.34 g H_2

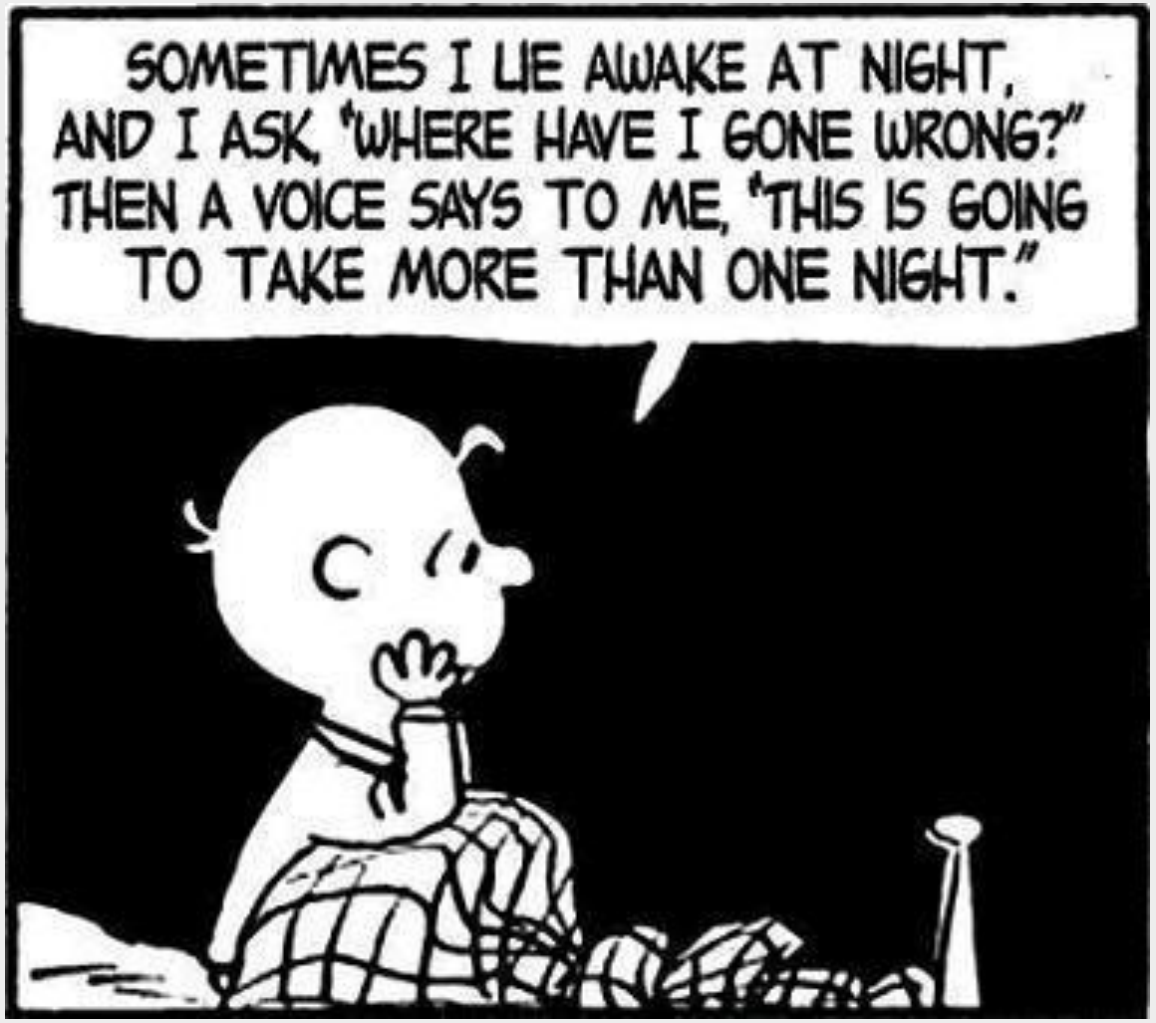
LOTS of possible routes!

- Just follow the mole highway
- Use dimensional analysis
- Flip conversion factors
- Cancel units



Things don't always work perfectly…

In the lab sometimes you don't make 100% of what your stoichiometry calculation says you should make



Theoretical Yield

The quantities that the stoichiometry calculations predict *should* be made

Actual/Experimental Yield

The quantity that you *actually* made in the lab experiment

% Yield

How good did you do!?

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

Not the same as % error!!!

Careful finding extra stuff online!

Do not do anything that says “limiting reagents” – we haven’t learned that yet. Don’t do problems that give you two starting values (you start with 15 grams of N_2 and 7 grams of H_2, how much NH_3 can you make?) – that is a limiting reagent problem. We will do limiting reagents after winter break!

Class Group Practice

15 g sodium nitrate and excess calcium hydroxide react. How many grams of your calcium containing product can be made?

14.5 g

$Ca(NO_3)_2$

Class Individual Practice – timed!

15 g magnesium nitrite and excess ammonium phosphate react. How many grams of your magnesium containing product can be made?

11.3 g

$Mg_3(PO_4)_2$

YouTube link to presentation

https://youtu.be/FjNpLz_Wxt4