Stoichiometry

Chef's need a recipe in order to make good food

Chemists need a recipe to do anything – you've already learned about the chemistry recipe.

The recipe for chemistry is a balanced chemical equation!

Just like a recipe tells a chef how much of each ingredient to use to get a certain amount of food, a balanced chemical equation tells a chemist how much of each reactant they need to make a certain amount of the product.

Let's look at the synthesis of water:

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

Q: What does this mean?
A: We need 2 moles of hydrogen gas for every one mole of oxygen gas in order to produce two moles of water

Q: Why is this important?
A: Now we can know the amount of **any** substance compared to an amount of **any other** substance - because we know the **MOLE RATIO**

$2H_2 + O_2 \rightarrow 2H_2O$

Q: How many moles of hydrogen gas do you need if you need to produce 10 moles water?

A: You would need **10 moles** of hydrogen gas!

Q: How many moles of oxygen gas would you need to make the 10 moles of water?

A: You would need only **5 moles** of oxygen gas!

Q: What if you only had 4 moles of oxygen gas? How many moles of water could you make?

A: You could only make **8 moles** of water.

Step 1: Given over 1

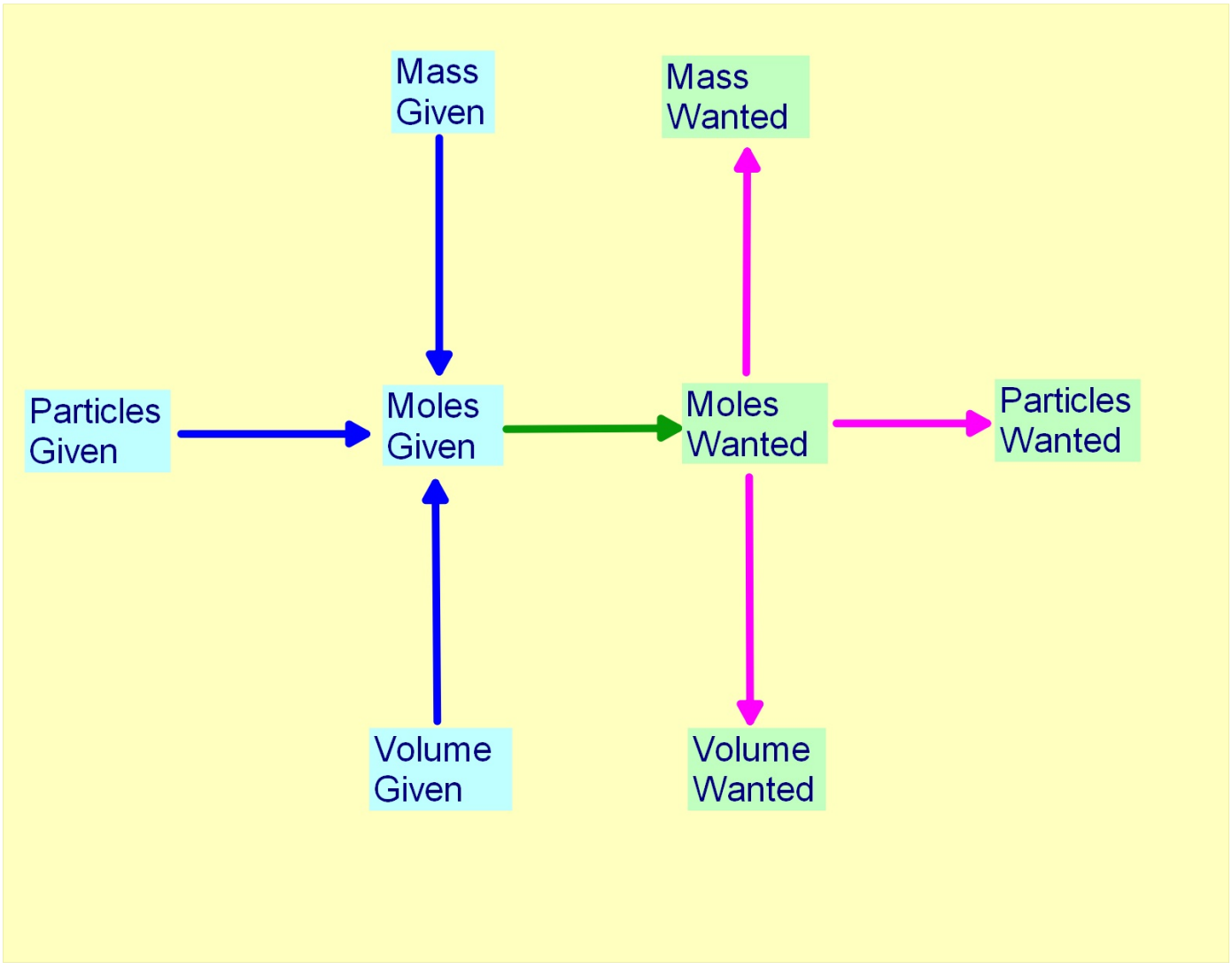
Step 2: Use MOLE RATIO to go to Moles Wanted with Moles Given on bottom

MOLE ROAD MAP

Because MOLES is a standard unit in chemistry, we can relate any other important unit to the mole.

We can then convert between substances in the same way we convert between units, using **dimensional analysis!**

We can follow the **Mole Road Map** to get from one unit of one substance to another unit of a different substance


Mass Given
Mass Wanted
Particles Given
Moles Given
Moles Wanted
Particles Wanted
Volume Given
Volume Wanted

$2H_2 + O_2 \rightarrow 2H_2O$

Q: How many grams of water can be produced if you start with 3 moles O_2?

Step 1: Given over 1

Step 2: Cancel out given unit with MOLE RATIO

Mole Given Bottom, Mole Wanted Top

Step 3: Use MOLAR MASS to go to grams wanted

_____ _____ _____

$2H_2 + O_2 \rightarrow 2H_2O$

Q: How many grams of oxygen are needed to react completely with 20.5g H_2?

Step 1: Given over 1

Step 2: Cancel out Mass Given (bottom) and go to MOLES Given (top)

Step 3: Use MOLE RATIO to switch to Wanted

Step 4: Cancel out Moles Wanted (bottom) and go to Mass Wanted (top)

_____ _____ _____ _____

$2H_2 + O_2 \rightarrow 2H_2O$

Q: How many liters of hydrogen are needed to make 56.6g water?

Step 1: Given over 1

Step 2: Go to Moles Given

Step 3: Use Mole Ratio

Step 4: Use MOLAR VOLUME (22.4L=1mol) to go to Volume Wanted

_____ _____ _____ _____

$2H_2 + O_2 \rightarrow 2H_2O$

Q: What volume of oxygen is required to react completely with 10.0L H_2?

Step 1: Given over 1

Step 2: Use Molar Volume to go to Moles Given

Step 3: Use Mole Ratio to go to Moles Wanted

Step 4: Use Molar Volume to go to Volume Wanted.

_____ _____ _____ _____

$2H_2 + O_2 \rightarrow 2H_2O$

Q: How many moles of water can be produced from 3.55L oxygen gas?

Step 1: Given over 1

Step 2: Use Molar Volume to go to Moles Given

Step 3: Use Mole Ratio to go to Moles Wanted

_____ _____ _____

$$CH_4(g) + 2\,O_2(g) \longrightarrow CO_2(g) + 2\,H_2O(\ell)$$

1. How many grams of carbon dioxide can be made from 13.7L methane gas?

2. How many liters of oxygen gas are required to produce 29.4g water?

$CaCl_2(aq) + Li_2CO_3(aq) \longrightarrow CaCO_3(s) + LiCl(aq)$

(Is this reaction balanced?)

3. What mass of lithium carbonate is needed to produce 5.78g calcium carbonate?

4. How much lithium chloride (g) is produced from 27.3g calcium chloride?

Limiting Reagent Problems

$2\,AgNO_3(aq) + Cu(s) \longrightarrow Cu(NO_3)_2(aq) + 2\,Ag(s)$

Q: How much silver (in g) can be made from the reaction of 2.75g silver nitrate and 3.45g copper wire?

One of the reactants will be used up before the other - but which one?

We need to convert each given to the product in question, and then see which gives us the lower amount - this will be our LIMITING REAGENT!

$2\,AgNO_3(aq) + Cu(s) \longrightarrow Cu(NO_3)_2(aq) + 2\,Ag(s)$

Q: How much silver (in g) can be made from the reaction of 2.75g silver nitrate and 3.45g copper wire?

_____ _____ _____ _____

_____ _____ _____ _____

What amount of silver will be produced? _____
Which reactant is limiting? _____
Which reactant is in excess? _____

$2\,AgNO_3(aq) + Cu(s) \longrightarrow Cu(NO_3)_2(aq) + 2\,Ag(s)$

How much silver can be produced from the reaction of 5.00g copper and 5.00g silver nitrate?

What amount of silver will be produced? _____
Which reactant is limiting? _____
Which reactant is in excess? _____

$2\,AgNO_3(aq) + Cu(s) \longrightarrow Cu(NO_3)_2(aq) + 2\,Ag(s)$

Using the information from the previous problem, determine the amount of excess reagent that will be used up.

We need to start with the limiting reagent and convert to the excess reagent. (g to g)

_____ _____ _____ _____

This is the amount of excess that was used up.

$2\,AgNO_3(aq) + Cu(s) \longrightarrow Cu(NO_3)_2(aq) + 2\,Ag(s)$

Ok, so how much excess reagent is left over?

For this, we need to do a simple subtraction.

Excess Initial

\- **Excess Used**

Excess Left Over

$$C_3H_8 + O_2 \longrightarrow CO_2 + H_2O$$

1. Balance the equation!
2. If you start with 12.5g propane & 5.50L oxygen gas, what volume of carbon dioxide will be produced?

3. Which reactant is limiting? _____
4. Which reactant is in excess? _____
5. How much excess is used? _____

6. How much excess is left over? _____