

## SUMMING UP CHEMICAL NOMENCLATURE

- You need to be able to tell, by looking at a name OR a formula, what kind of compound you are working with!

DON'T GET THE NAMING SYSTEMS MIXED UP! EACH KIND OF COMPOUND IS NAMED WITH ITS OWN SYSTEM!

FROM A CHEMICAL NAME

- If the name has a Roman numeral, the name of a metal, or "ammonium", the compound is likely IONIC
- If the name has a Greek prefix AND the prefix is NOT in front of the word "hydrate", the compound is BINARY MOLECULAR
- If the name contains the word "acid":
  - ... and starts with "hydro-", then the compound is a BINARY ACID
  - ... and does not start with "hydro-", the compound is an OXYACID

78 FROM A CHEMICAL FORMULA

- if the formula contains a metal or the  $\text{NH}_4^+$  ion, it is likely IONIC

- If the formula starts with H and is not either water ( $\text{H}_2\text{O}$ ) or hydrogen peroxide ( $\text{H}_2\text{O}_2$ ), the compound is likely an ACID. Which kind?

- BINARY ACIDS contain only two elements

- OXYACIDS contains oxygen

- If the formula contains only nonmetals (and is not an ammonium compound or an acid), the compound is likely MOLECULAR

Examples:

$\text{PCl}_3$  : BINARY MOLECULAR  
Name: phosphorus trichloride

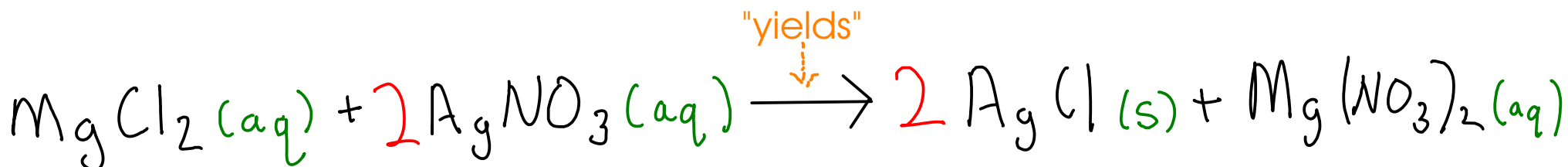
$\text{NH}_4\text{Cl}$  : IONIC (ammonium ion)  
Name: ammonium chloride

$\text{H}_3\text{PO}_4$  : OXYACID (hydrogen, phosphate)  
Name: phosphoric acid

$\text{FeCl}_3$  : IONIC (iron, metal)  
Name: iron(III) chloride

## CHEMICAL EQUATIONS

- are the "recipes" in chemistry
- show the substances going into a reaction, substances coming out of the reaction, and give other information about the process



REACTANTS - materials that are needed for a reaction

PRODUCTS - materials that are formed in a reaction

COEFFICIENTS - give the ratio of molecules/atoms of one substance to the others

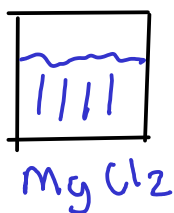
PHASE LABELS - give the physical state of a substance:

(s) - solid

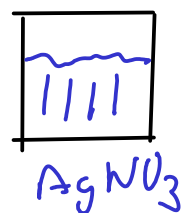
(l) - liquid

(g) - gas

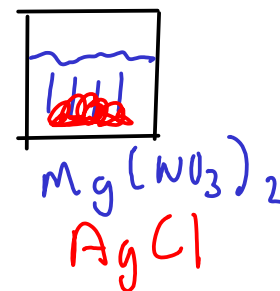
(aq) - aqueous. In other words, dissolved in water



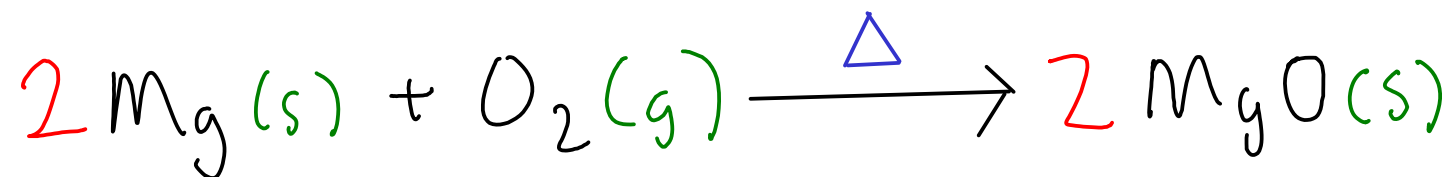
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## CHEMICAL EQUATIONS



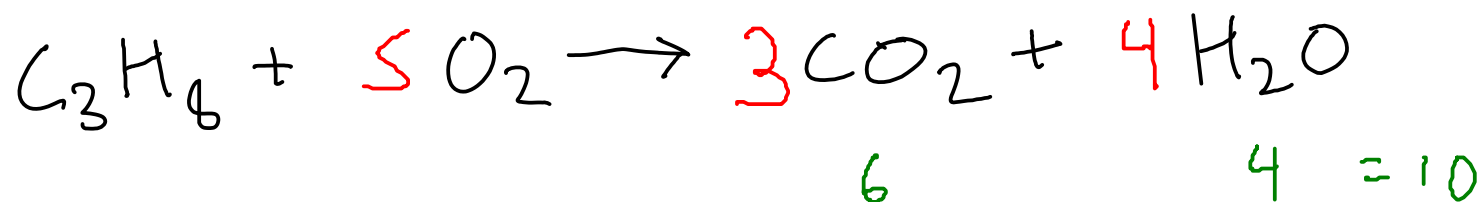
REACTION CONDITIONS - give conditions necessary for chemical reaction to occur. May be:

- $\Delta$  apply heat
  - catalysts - substances that will help reaction proceed faster
  - other conditions, such as required temperatures
- Reaction conditions are usually written above the arrow, but may also be written below if the reaction requires several steps or several different conditions

## COEFFICIENTS

- Experimentally, we can usually determine the reactants and products of a reaction
- We can determine the proper ratios of reactants and products WITHOUT further experiments, using a process called BALANCING
- BALANCING a chemical equation is making sure the same number of atoms of each element go into a reaction as come out of it.
- A properly balanced chemical equation has the smallest whole number ratio of reactants and products.
- There are several ways to do this, but we will use a modified trial-and-error procedure.

## BALANCING



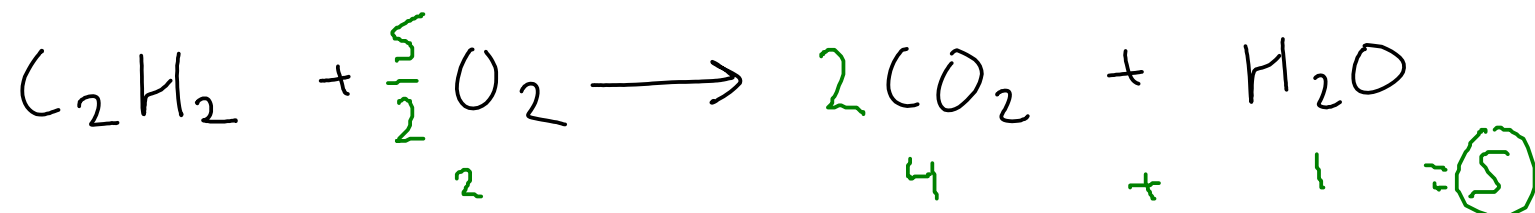
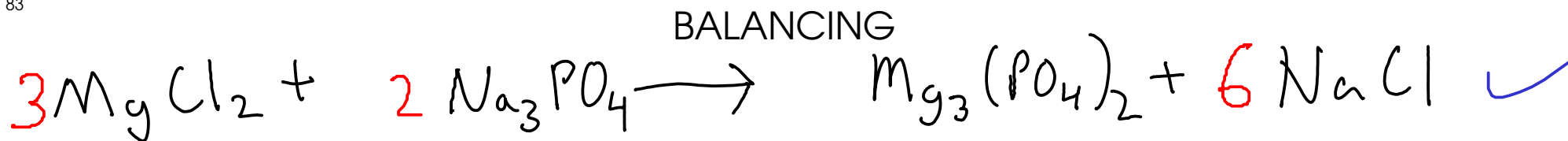
① Pick an element. Avoid (if possible) elements that appear in more than one substance on each side of the equation.

② Change the coefficients on substances containing this element so that the same number of atoms of the element are present on each side. **CHANGE AS LITTLE AS POSSIBLE!**

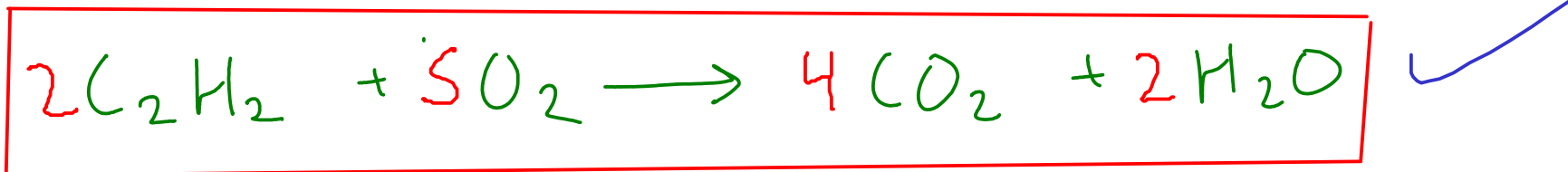
③ Repeat 1-2 until all elements are done.

④ Go back and quickly VERIFY that you have the same number of atoms of each element on each side. If you used any fractional coefficients, multiply each coefficient by the DENOMINATOR of your fraction.

**Use SMALLEST WHOLE NUMBER RATIOS!**

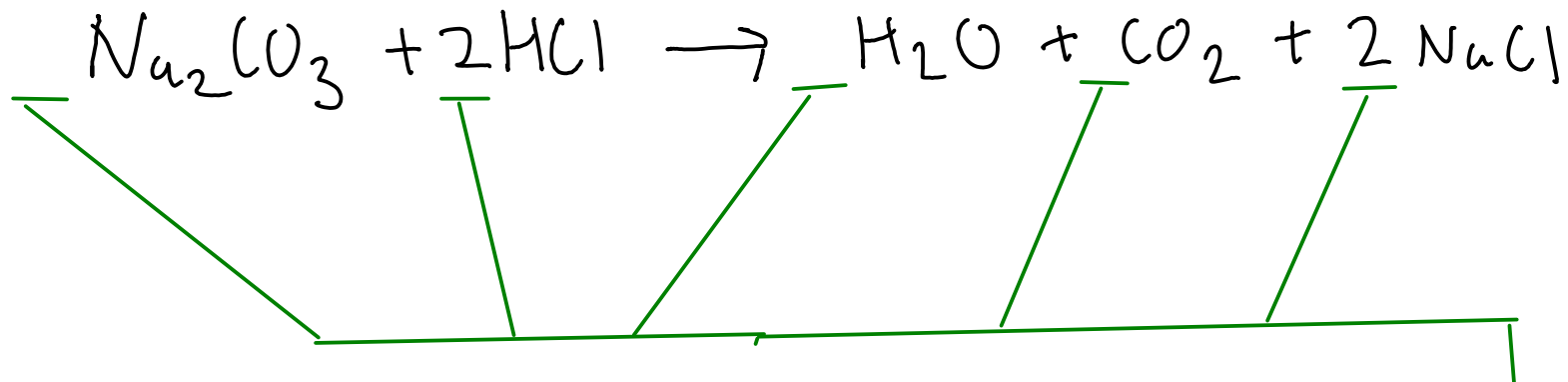


We used 5/2 (or 2 and 1/2) as the coefficient for oxygen on the left. BUT, we really want this equation to be balanced using the simplest WHOLE NUMBER ratio. So what now? Multiply all the coefficients by the denominator of the fraction (in this case, 2)



- 1) Avoid H, balance S - since H appears in three different substances.
- 2) Avoid O, balance Na - since O appears in ALL of the compounds
- 3) Balance H, since it shows up fewer times than O
- 4) Balance O. (It's already done)

## 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!

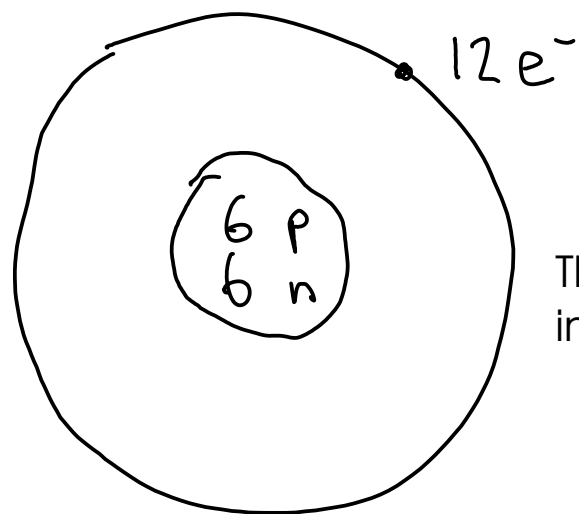


## THE MOLE CONCEPT

- A "mole" of atoms is  $6.022 \times 10^{23}$  atoms

Why so big? Because atoms are so small!

- Why - in the metric dominated world of science - do we use such a strange number for quantity of atoms?



carbon-12

The mole is also defined as the number of carbon-12 atoms in exactly 12 g of carbon-12

## THE MOLE CONCEPT

- Why define the mole based on an experimentally-measured number?
- The atomic weight of an element (if you put the number in front of the unit GRAMS) is equal to the mass of ONE MOLE of atoms of that element!

Carbon (C): Atomic mass 12.01 ~~amu~~ → 12.01 g

↓

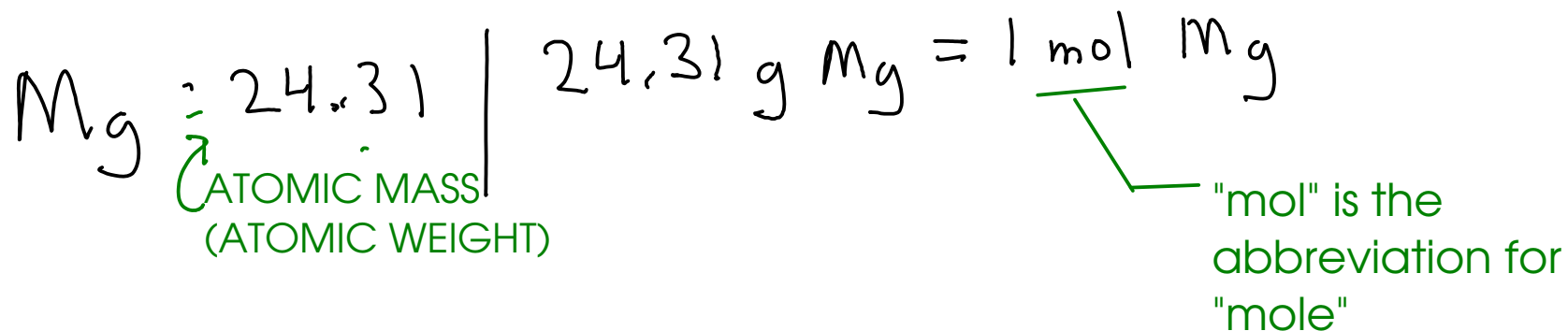
the mass of ONE MOLE of naturally-occurring carbon atoms

Magnesium (Mg): 24.31 g = the mass of ONE MOLE OF MAGNESIUM ATOMS

- So, using the MOLE, we can directly relate a mass and a certain number of atoms!

## RELATING MASS AND MOLES

- Use DIMENSIONAL ANALYSIS (a.k.a "drag and drop")
- Need CONVERSION FACTORS - where do they come from?
- We use ATOMIC WEIGHT as a conversion factor.



Example: How many moles of atoms are there in 250. g of magnesium metal?

$$24.31 \text{ g Mg} = 1 \text{ mol Mg}$$

$$250. \text{ g Mg} \times \frac{1 \text{ mol Mg}}{24.31 \text{ g Mg}} = \boxed{10.3 \text{ mol Mg}}$$

\* Atomic weight is a measured number (in other words, it has significant figures). Usually, though, the measured mass or number of moles limits the figures in your answer, since you can typically look up a more precise atomic weight if needed.

Example: You need 1.75 moles of iron. What mass of iron do you need to weigh out on the balance?

$$55.85 \text{ g Fe} = 1 \text{ mol Fe}$$

$$1.75 \text{ mol Fe} \times \frac{55.85 \text{ g Fe}}{1 \text{ mol Fe}} = 97.7 \text{ g Fe}$$

## WHAT ABOUT COMPOUNDS? FORMULA WEIGHT

Example: 25.0 g of WATER contain how many MOLES of water molecules?

$$\text{H}_2\text{O} : \quad \text{H} : 2 \times 1.008 = 2.016$$

$$\quad \quad \quad \text{O} : 1 \times 16.00 = \underline{16.00}$$

18.016 ← FORMULA WEIGHT of water

$$18.016 \text{ g H}_2\text{O} = \text{mol H}_2\text{O}$$

FORMULA WEIGHT is the mass of one mole of either an element OR a compound.

$$25.0 \text{ g H}_2\text{O} \times \frac{\text{mol H}_2\text{O}}{18.016 \text{ g H}_2\text{O}} = 1.39 \text{ mol H}_2\text{O}$$

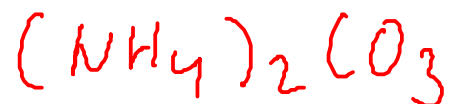
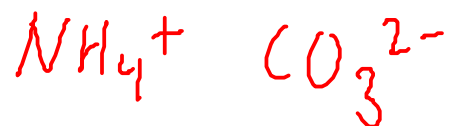
Formula weight goes by several names:

- For atoms, it's the same thing as ATOMIC WEIGHT or ATOMIC MASS
- For molecules, it's called MOLECULAR WEIGHT or MOLECULAR MASS
- Also called "MOLAR MASS"

Example: How many grams of ammonium carbonate do we need to weigh out to get 3.65 moles of ammonium carbonate?

To change from moles to mass, we need to use FORMULA WEIGHT of ammonium carbonate. But to get the formula weight, we must ...

... find the FORMULA of ammonium carbonate



$$\text{N} : 2 \times 14.01$$

$$\text{H} : 8 \times 1.008$$

$$\text{C} : 1 \times 12.01$$

$$\text{O} : 3 \times 16.00$$

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$$96.094$$

Now, we can find the FORMULA WEIGHT of the compound...

$$96.094 \text{ g } (\text{NH}_4)_2\text{CO}_3 = \text{mol } (\text{NH}_4)_2\text{CO}_3 \leftarrow \text{Write the formula weight as a conversion factor...}$$

$$3.65 \text{ mol } (\text{NH}_4)_2\text{CO}_3 \times \frac{96.094 \text{ g } (\text{NH}_4)_2\text{CO}_3}{\text{mol } (\text{NH}_4)_2\text{CO}_3} =$$

$$= \boxed{351 \text{ g } (\text{NH}_4)_2\text{CO}_3}$$