BALANCING

$3MgCl_2 + 2Na_3PO_4 \longrightarrow Mg_3(PO_4)_2 + 6NaCl$ ✓

$C_2H_2 + 2\frac{1}{2}O_2 \longrightarrow 2CO_2 + H_2O$

$\frac{1}{2}5 \quad ; \quad 4 + 1 = 5$

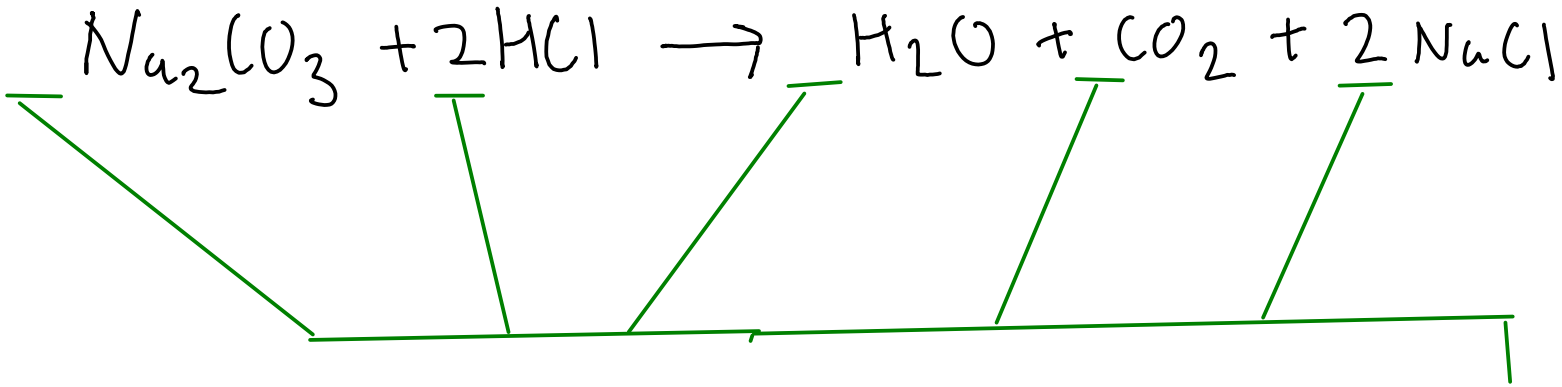
To get rid of the coefficient 2 1/2 (which we needed to use to balance the OXYGEN), we will multiply ALL of the coefficients by 2 (the denomnator of the fraction). This will give us an equivalent set of coefficients without the fraction.

$2C_2H_2 + 5O_2 \longrightarrow 4CO_2 + 2H_2O$ ✓

$H_2SO_4 + 2NaOH \longrightarrow Na_2SO_4 + 2H_2O$

1 - Skip H, since it appears twice on the left. Balance S first, instead.
2 - Skip O, since it appears in all four compounds. Balance Na next.
3 - Balance H, since it's easier than O ... and we already have one of its three appearances with a coefficient set.
4 - Balance O. (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!

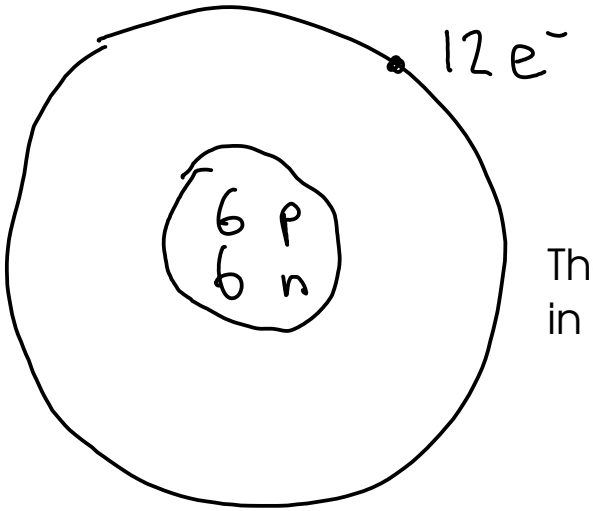
- measurements are usually MASS (and sometimes VOLUME), NOT number of atoms or molecules!

THE MOLE CONCEPT

- A "mole" of atoms is 6.022×10^{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.

$Mg = 24.31$ (Atomic mass) | $24.31\ g\ Mg = mol\ Mg$

"mol" is the abbreviation for "mole"

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

$24.31\ g\ Mg = mol\ Mg$

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

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

Fe: atomic weight of 55.85 amu

$$55.85\ g\ Fe = mol\ Fe$$

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

WHAT ABOUT COMPOUNDS? FORMULA WEIGHT

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

H_2O: H: $2 \times 1.008 = 2.016$

O: $1 \times 16.00 = 16.00$

18.016 ← FORMULA WEIGHT of water

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

$18.016\ g\ H_2O = mol\ H_2O$

$$25.0\ g\ H_2O \times \frac{mol\ H_2O}{18.016\ g\ H_2O} = \boxed{1.39\ mol\ H_2O}$$

Formula weight goes by several names:

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

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

First, let's find the FORMULA of barium chloride:

Ba^{2+} Cl^-

Cl^-

$BaCl_2$

After finding the formula, calculate the FORMULA WEIGHT:

$BaCl_2$ Ba: 1×137.3

Cl: 2×35.45

$\frac{}{208.2\ g\ BaCl = mol\ BaCl_2}$

Finally, convert moles barium chloride to mass

$$3.65\ mol\ BaCl_2 \times \frac{208.2\ g\ BaCl_2}{mol\ BaCl_2} = \boxed{760\ g\ BaCl_2}$$

$(7.60 \times 10^2\ g\ BaCl_2)$

PERCENTAGE COMPOSITION

- sometimes called "percent composition" or "percent composition by mass"
- the percentage of each element in a compound, expressed in terms of mass

Example: Find the percentage composition of barium chloride.

$BaCl_2$: Ba: $1 \times 137.3 = 137.3$

Cl: $2 \times 35.45 = 70.90$

$208.2\ g\ BaCl_2 = mol\ BaCl_2$

These numbers are the masses of each element in a mole of the compound!

Ba: $\frac{137.3\ g\ Ba}{208.2\ g\ BaCl_2} \times 100 =$ 65.95 % Ba

Cl: $\frac{70.90\ g\ Cl}{208.2\ g\ BaCl_2} \times 100 =$ 34.05 % Cl

These percentages should sum to 100% within roundoff error.