BALANCING

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

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

$2 \neq 5$; $4 + 1 = 5$

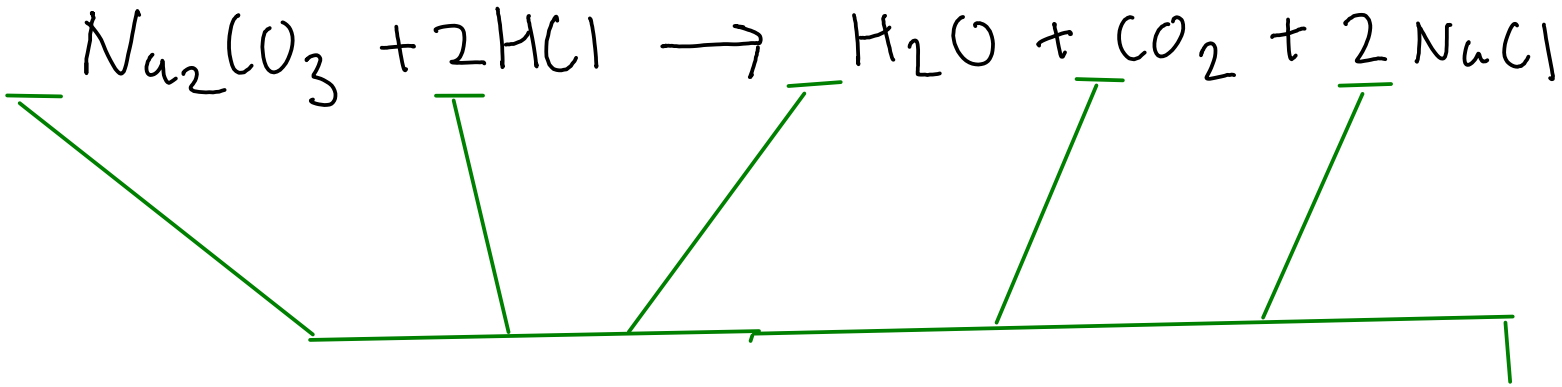
Since we need WHOLE NUMBER coefficients, we can MULTIPLY all the coefficients by a number to get rid of fraction. (This works because the coefficients are a ratio). What number to use? Use the denominator of the fraction (here, 2).

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

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

1) Avoid H. Start with S. (H shows up twice on the left)
2) Avoid O. Do Na next. (O shows up in all four compounds!)
3) Balance H. (Shows up in three of the four compounds, instead of all four like O)
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!

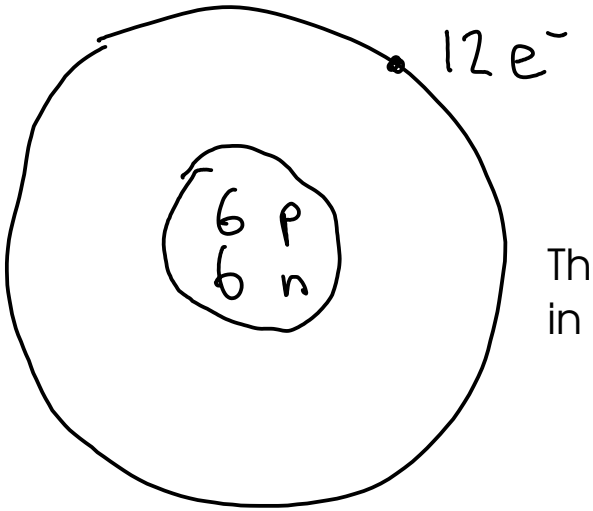
- measurements are usually MASS (and sometimes VOLUME), NOT number of atoms or molecules!

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?

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

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

Fe : 55.85 atomic weight

$$55.85\ g\ Fe = 1\ mol\ Fe$$

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

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.

$18.016\ g\ H_2O = mol\ H_2O$

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

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, we need the CHEMICAL FORMULA of barium chloride!

Ba^{2+} Cl^-

Cl^-

$BaCl_2$

After finding the formula, then find the FORMULA WEIGHT

$Ba = 1 \times 137.3$

$Cl = 2 \times 35.45$

$208.2\ g\ BaCl_2 = mol\ BaCl_2$

Finally, use the formula weight to relate moles and mass

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

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