PREDICTING SINGLE REPLACEMENT REACTIONS

Activity (↑)	
Sodium	Na^{+}
Magnesium	Mg^{2+}
Aluminum	Al^{3+}
Zinc	Zn^{2+}
Iron	Fe^{2+}
Lead	Pb^{2+}
Hydrogen	H^{+}
Copper	Cu^{2+}
Silver	Ag^{+}
Gold	Au^{3+}

$$Pb(s) + 2HCl(aq) \rightarrow PbCl_2(s) + H_2(g)$$

Lead is MORE ACTIVE than hydrogen, so we would expect lead to replace hydrogen in this reaction.

$$Pb(NO_3)_2(aq) + Zn(s) \rightarrow Zn(NO_3)_2(aq) + Pb(s)$$

Zinc is MORE ACTIVE than lead, so we expect zinc to replace lead.

$$Ag(s) + H_2SO_4(aq) \rightarrow \text{NO REACTION}$$

Silver is LESS ACTIVE than hydrogen, so we expect that no reaction will occur. Silver will not replace hydrogen.

$$Mg(s) + ZnSO_4(aq) \rightarrow MgSO_4(aq) + Zn(s)$$

Since magnesium is MORE ACTIVE than zinc, we expect a reaction to occur. Magnesium should replace zinc.

CHEMICAL CALCULATIONS - RELATING MASS AND ATOMS

$$\_\_ Na_2CO_3 + \_\_ 2HCl \rightarrow \_\_ H_2O + \_\_ CO_2 + \_\_ 2NaCl$$

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!

MASS ↑ Na_2CO_3 solid

VOLUME ↑ HCl solution

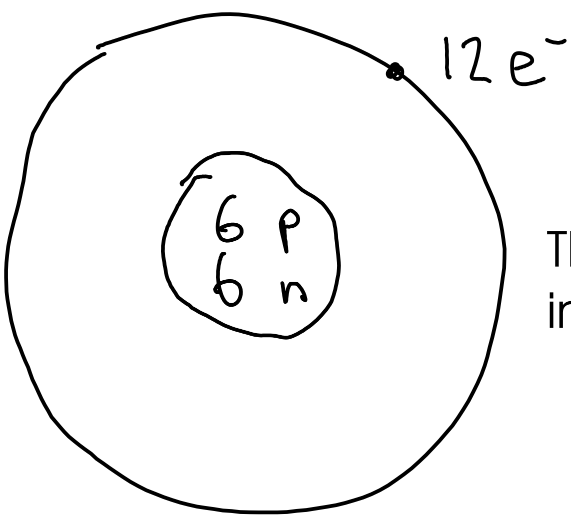
... so how do we relate atoms and molecules with things we routinely measure in lab - like grams and milliliters?

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 | 24.31 g Mg = 1 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

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