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 = mol Mg

Atomic mass

"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?

We need to use the ATOMIC WEIGHT as a conversion factor:

Fe : 55.85 (from periodic table)

55.85 g Fe = mol Fe

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

WHAT ABOUT COMPOUNDS? FORMULA WEIGHT

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

H_2O: H : 2 x 1.008 = 2.016
O : 1 x 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.

$18.016\ g\ H_2O = mol\ H_2O$

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

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, we need to know the formula of barium chloride. (This one is IONIC)

Ba^{2+} Cl^-

Cl^-

$BaCl_2$

NEXT, find the FORMULA WEIGHT of barium chloride

$BaCl_2$ - Ba: 1 x 137.3 = 137.3 g

Cl: 2 x 35.45 = 70.90 g

208.2 g

208.2 g $BaCl_2$ = mol $BaCl_2$

FINALLY, caclulate the mass of barium chloride required

$$3.65 \text{ mol } BaCl_2 \times \frac{208.2 \text{ g } BaCl_2}{\text{mol } BaCl_2} = \boxed{76\bar{0} \text{ g } BaCl_2}$$

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 : $1 \times 137.3 = \boxed{137.3}$

Cl : $2 \times 35.45 = \boxed{70.90}$

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

$208.2 \text{ g } BaCl_2 = \text{mol } BaCl_2$

$$\% \text{ Ba}: \frac{137.3 \text{ g Ba}}{208.2 \text{ g total}} \times 100 = \boxed{65.95\% \text{ Ba}}$$

$$\% \text{ Cl}: \frac{70.90 \text{ g Cl}}{208.2 \text{ g total}} \times 100 = \boxed{34.05\% \text{ Cl}}$$

Within roundoff error, these should sum to 100%

So far, we have

- looked at how to determine the composition by mass of a compound from a formula
- converted from MASS to MOLES (related to the number of atoms/molecules)
- converted from MOLES to MASS

Are we missing anything?

- What about SOLUTIONS, where the desired chemical is not PURE, but found DISSOLVED IN WATER?
- How do we deal with finding the moles of a desired chemical when it's in solution?

MOLAR CONCENTRATION

- unit: MOLARITY (M): moles of dissolved substance per LITER of solution

dissolved substance

$$M = \text{molarity} = \frac{\text{moles of SOLUTE}}{\text{L SOLUTION}}$$

6.0 <u>M</u> HCl solution: $\frac{6.0 \text{ mol HCl}}{\text{L}}$

If you have 0.250 L (250 mL) of 6.0 M HCl, how many moles of HCl do you have?

6.0 mol HCl = L

$$0.250 \text{ L} \times \frac{6.0 \text{ mol HCl}}{\text{L}} = \boxed{1.50 \text{ mol HCl}}$$

If you need 0.657 moles of hydrochloric acid, how many liters of 0.0555 M HCl do you need to measure out?

$0.0555 \text{ mol HCl} = \text{L}$

$$0.657 \text{ mol HCl} \times \frac{\text{L}}{0.0555 \text{ mol HCl}} = \boxed{11.8 \text{ L}}$$

(11800 mL)

What if we used 6.00 M HCl?

$6.00 \text{ mol HCl} = \text{L}$

$$0.657 \text{ mol HCl} \times \frac{\text{L}}{6.00 \text{ mol HCl}} = \boxed{0.110 \text{ L}}$$

$(11\bar{0} \text{ mL})$