CHAPTER 2

CHEMICAL FORMULAS & COMPOSITION STOICHIOMETRY

One drop of water is about 0.05g or 0.05 ml

One drop of water contains about 1.67 x 10^{21} H_2O molecules

167,000,000,000,000,000,000 H_2O molecules

1.67 sextillion H_2O molecules

There are about 5 sextillion atoms in a drop of water

Chapter Goals

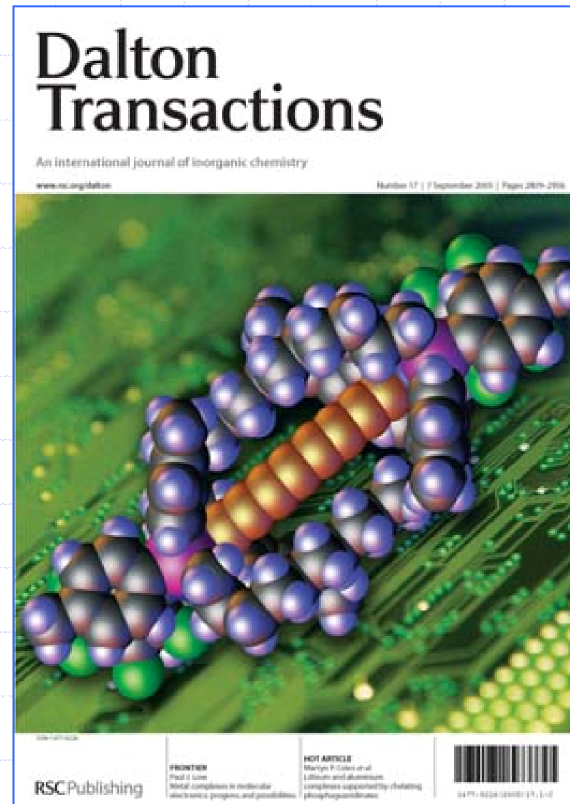
1. Atoms and Molecules
2. Chemical Formulas
3. Ions and Ionic Compounds
4. Names and Formulas of Some Ionic Compounds
5. Atomic Weights
6. The Mole

Chapter Goals

7. Formula Weights, Molecular Weights, and Moles
8. Percent Composition and Formulas of Compounds
9. Derivation of Formulas from Elemental Composition
10. Determination of Molecular Formulas
11. Some Other Interpretations of Chemical Formulas
12. Purity of Samples

Atoms and Molecules

- **Dalton's Atomic Theory - 1808**



John Dalton (1766-1844)

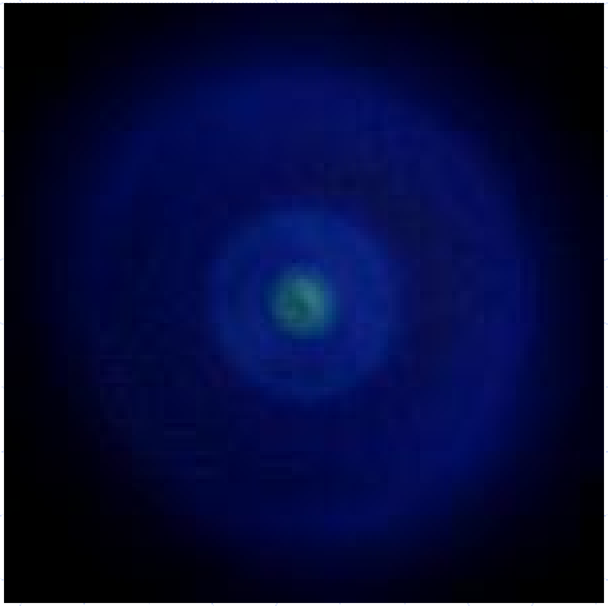
Atoms and Molecules

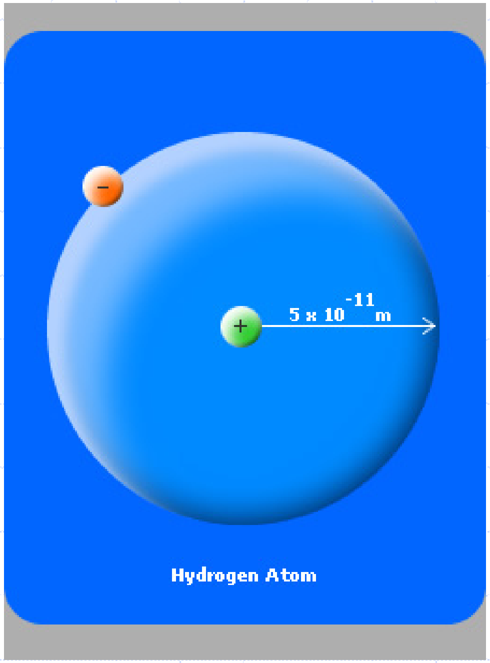
- Dalton's Atomic Theory - 1808
- Five postulates
  1. An element is composed of extremely small, indivisible particles called atoms.
  2. All atoms of a given element have identical properties that differ from those of other elements.
  3. Atoms cannot be created, destroyed, or transformed into atoms of another element.
  4. Compounds are formed when atoms of different elements combine with one another in small whole-number ratios.
  5. The relative numbers and kinds of atoms are constant in a given compound.
- Which of these postulates are correct today?

Atoms

- **Atom**
  - **the smallest particle of an element that maintains its identity through all chemical and physical changes**

Hydrogen Atom





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The Stuff That Makes Atoms

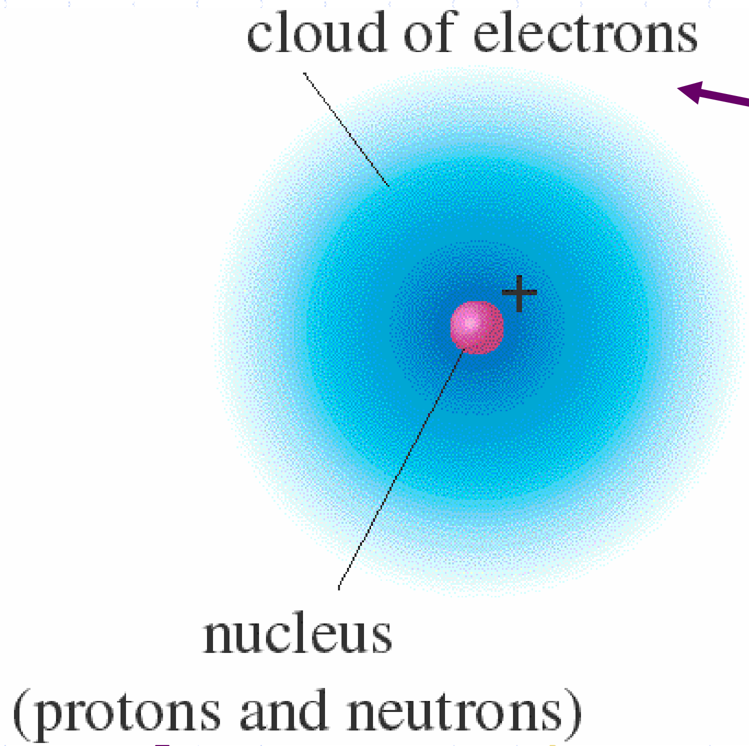
Although one can subdivide atoms into numerous *subatomic particles*, we will be concerned only with *protons, neutrons and electrons*.

Protons and neutrons are together in the *nucleus* of an atom, whereas electrons are in motion in orbits around the central nucleus.

Protons carry a positive electrical charge, electrons carry a negative charge, and neutrons carry no charge. Neutrons work to keep nuclei together.

Most atoms are electrically neutral, meaning that they have an equal number of protons and electrons.

The Stuff That Makes Atoms



negatively charged

positively charged

Different # of neutrons = isotopes: ^{12}C / ^{13}C / ^{14}C

Atomic Number

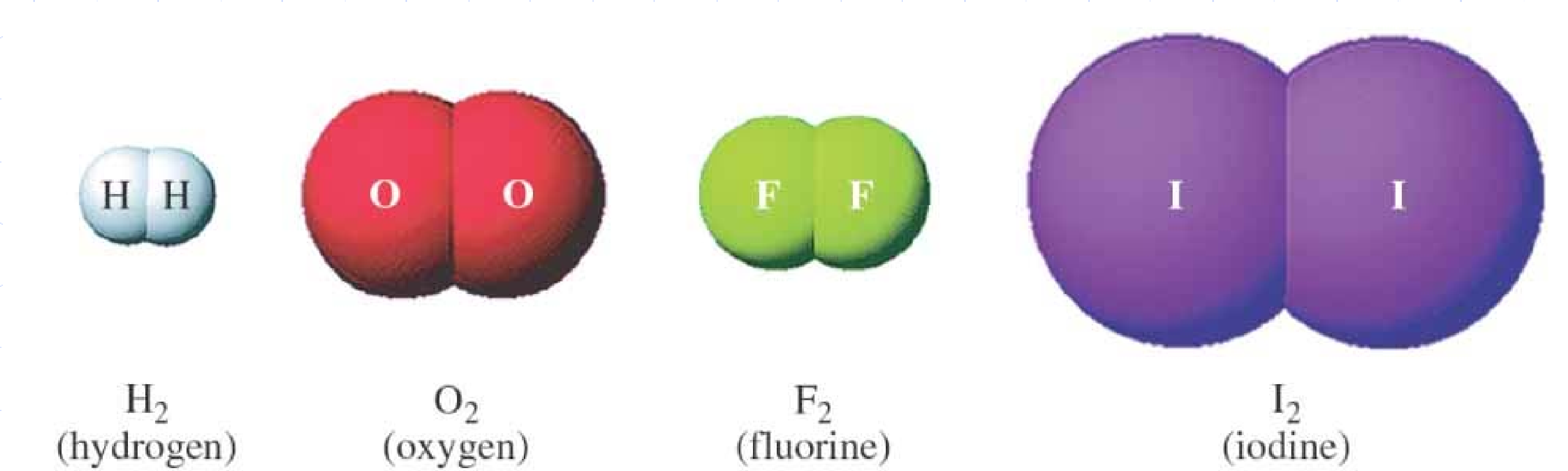
- **Atomic numeber (symbol is Z) of an element is defined as the number of protons in the nucleus**
  - **atomic number (Z) = # protons in the nucleus**
  - **# protons = # electrons (electroneutrality!)**

Atoms and Molecules

- A molecule is the smallest particle of an element that can have a stable independent existence.
  - Usually have 2 or more atoms bonded together

Atoms and Molecules

- Examples of molecules

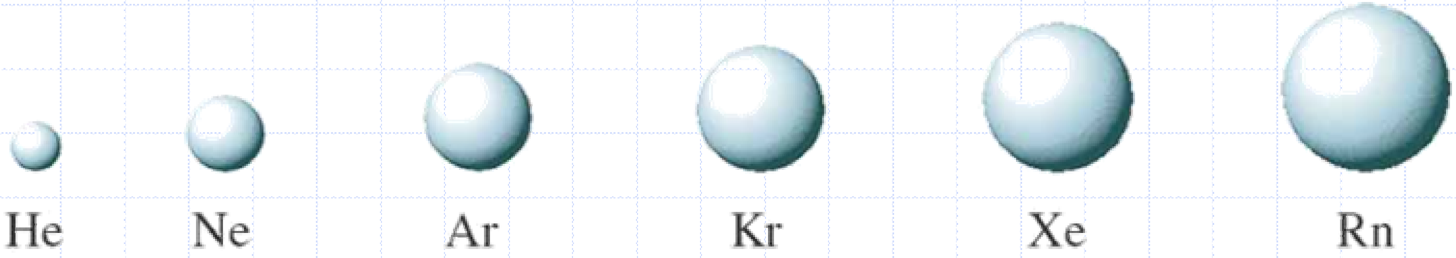


Chemical Formulas

- Chemical formula shows the chemical composition of the substance.
  - ratio of the elements present in the molecule or compound
- He, Au, Na – monatomic elements
- O_2, H_2, Cl_2 – diatomic elements
- O_3, S_4, P_8 - more complex elements
- H_2O, C_2H_5OH – compounds
  - Substance consists of two or more elements

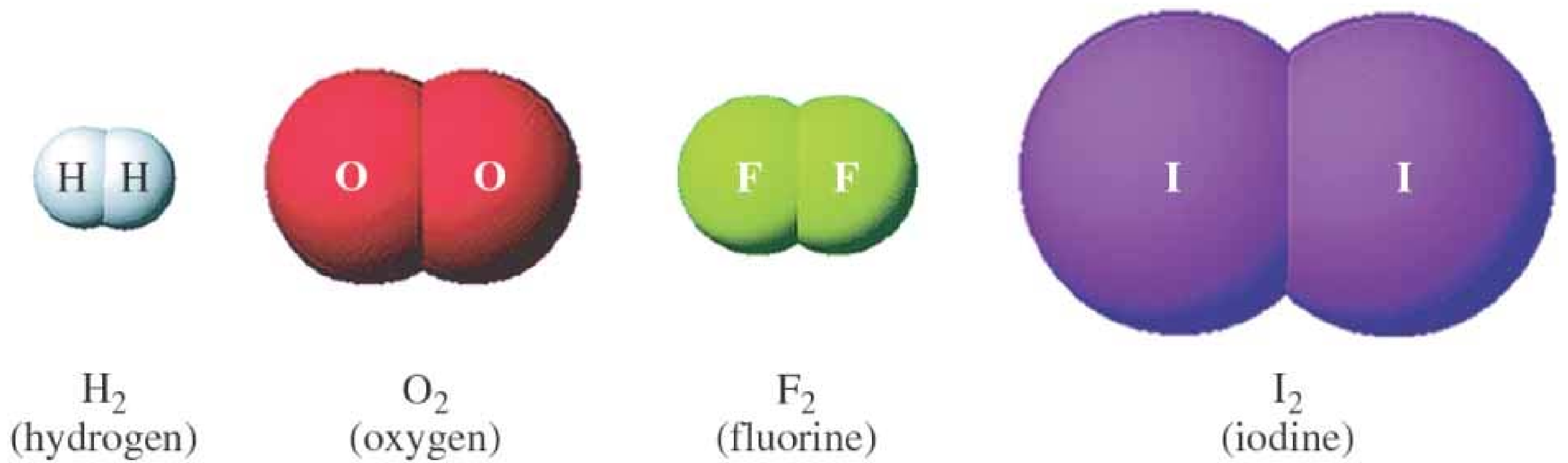
Chemical Formulas

- **monatomic elements**



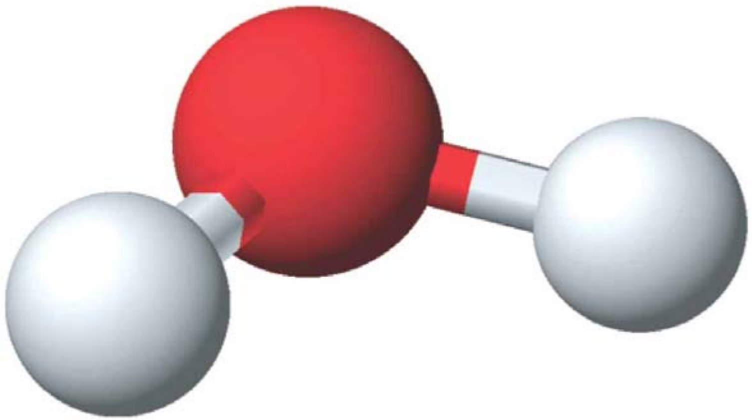
Chemical Formulas

- diatomic elements

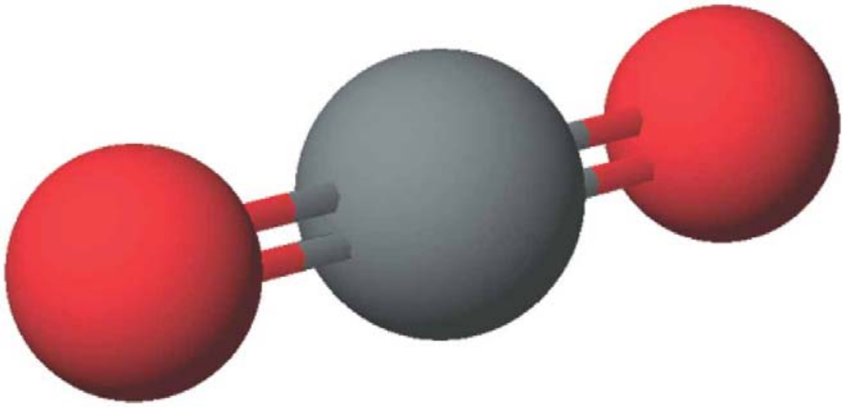


Chemical Formulas

- **triatomic elements**



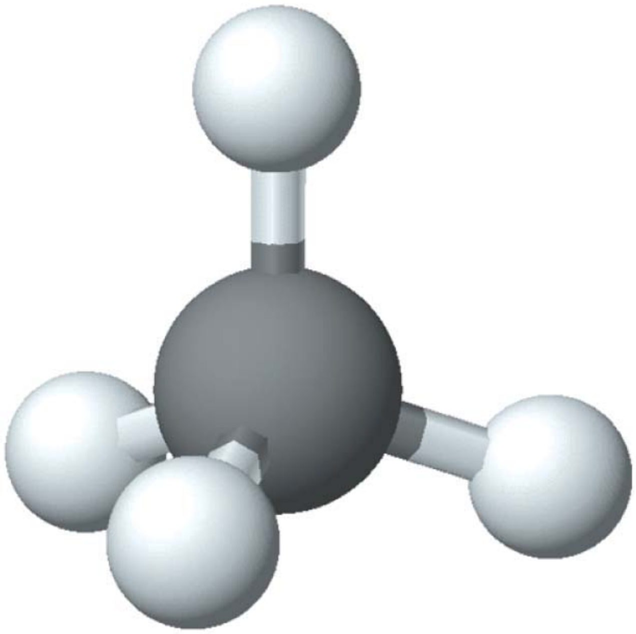
H_2O
(water)



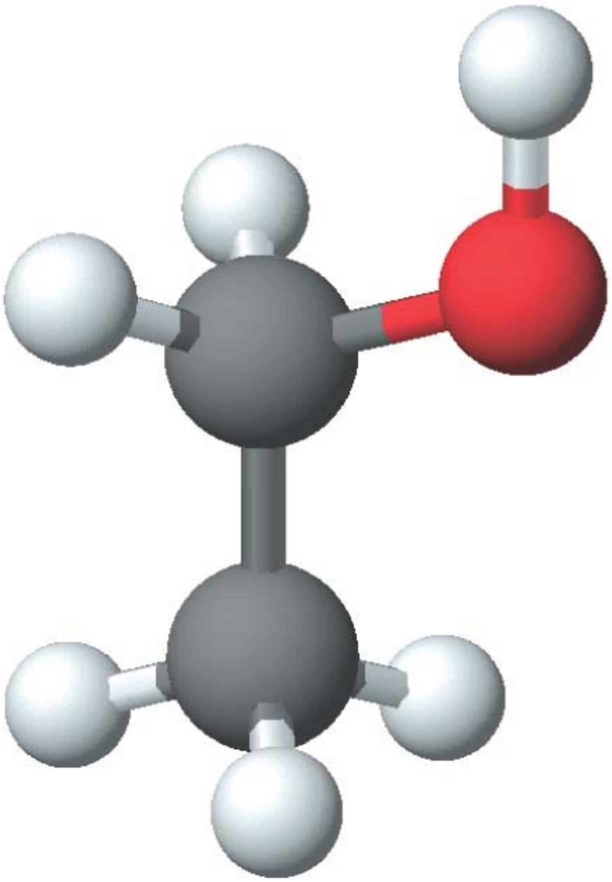
CO_2
(carbon dioxide)

Chemical Formulas

- H_2O, CH_3OH – compounds



CH_4
(methane)



C_2H_5OH
(ethyl alcohol)

Chemical Formulas

Compound	1 Molecule Contains
HCl	1 H atom & 1 Cl atom
H_2O	2 H atoms & 1 O atom
NH_3	1 N atom & 3 H atoms
C_3H_8	3 C atoms & 8 H atoms

Ions and Ionic Compounds

- Ions are atoms or groups of atoms that possess an electric charge.
- Two basic types of ions:
- Positive ions or cations
  - one or more electrons less than neutral
  - Na^+, Ca^{2+}, Al^{3+}
  - NH_4^+ - polyatomic cation
- Negative ions or anions
  - one or more electrons more than neutral
  - F^-, O^{2-}, N^{3-}
  - SO_4^{2-}, PO_4^{3-} - polyatomic anions

Ions and Ionic Compounds

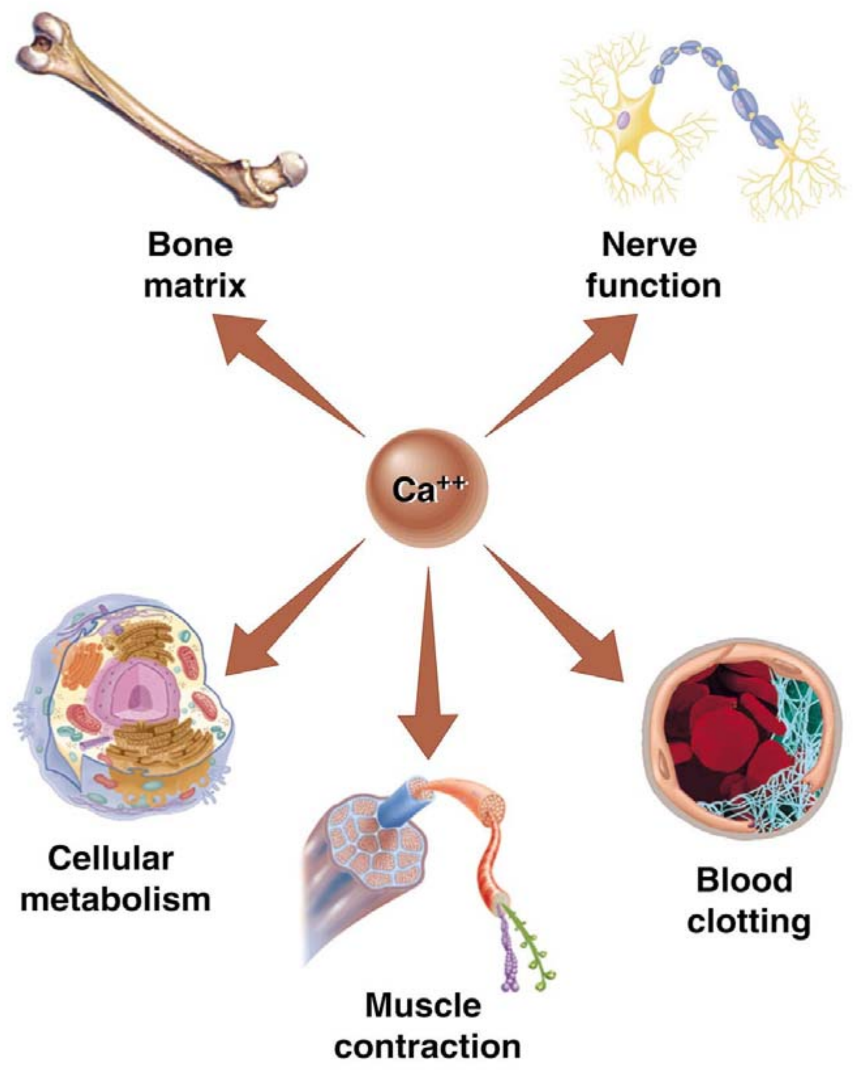
ion –
where the # of protons $\neq$ the # of electrons

cation –
where the # of protons > the # of electrons

anion –
where the # of protons < the # of electrons

Calcium

- Most abundant mineral in animal tissues
- Lots of functions
  - Bone structure
  - Nerve function
  - Blood clotting
  - Muscle contraction
  - Cellular metabolism



Other ions

Zinc Oxide
Zn^{2+}

Bismuth ion
Bi^{2+}

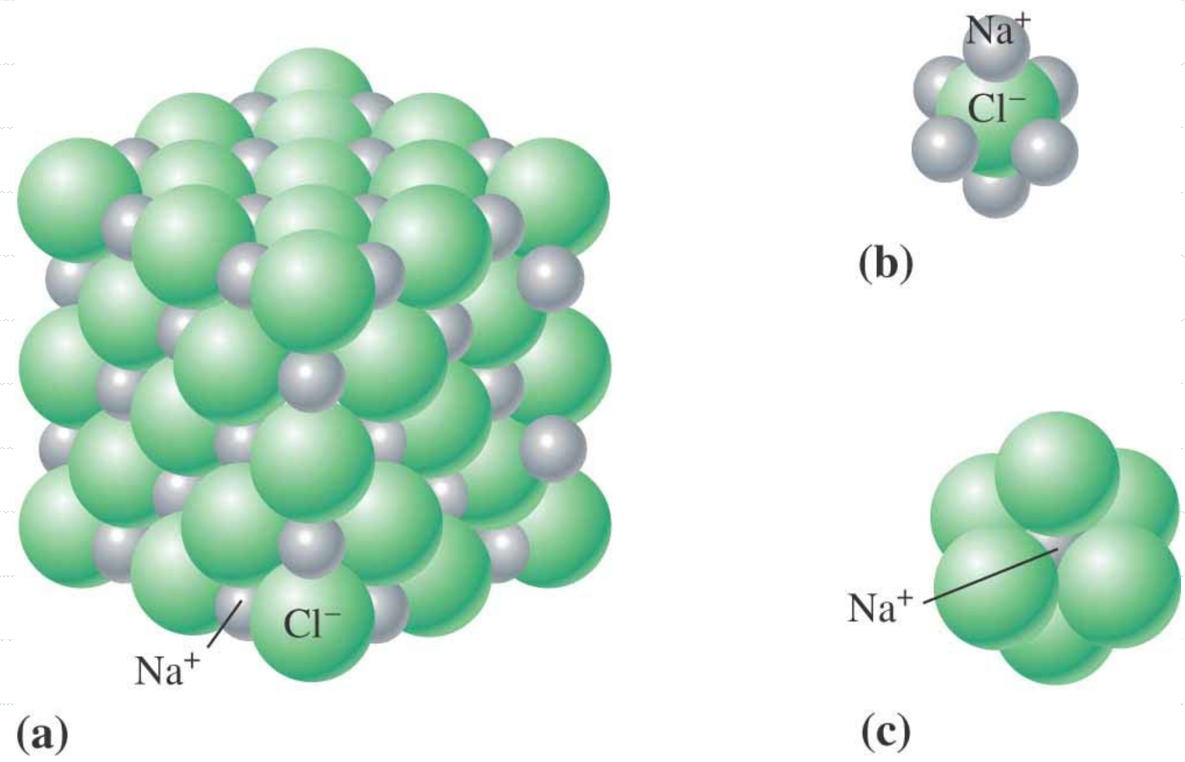
NaCl (common table salt)

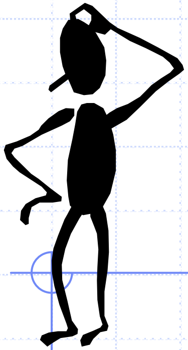
NaF (toothpaste to fight cavities)

Aluminum oxide (Al_2O_3). The mineral, corundum, is made of aluminum oxide. It is very hard, which is why it's used in sand paper.

Ions and Ionic Compounds

- Sodium chloride
  - table salt is an ionic compound





Do You Understand Ions?

How many protons and electrons are in ${}^{13}Al^{3+}$?

13 protons, 10 (13 – 3) electrons

How many protons and electrons are in ${}^{34}Se^{2-}$?

34 protons, 36 (34 + 2) electrons

Names and Formulas of Some Ionic Compounds

- Table 2-3 displays the formulas, charges, and names of some common ions
  - <u>You must</u> know the names, formulas, and charges of the common ions in table 2-3.

Common Cations (positive ions)

Formula	Charge	Name
Na^{+}	1+	sodium
K^{+}	1+	potassium
NH_4^{+}	1+	ammonium
Ag^{+}	1+	silver
Mg^{2+}	2+	magnesium
Ca^{2+}	2+	calcium
Zn^{2+}	2+	zinc
Cu^{+}	1+	copper(I)
Cu^{2+}	2+	copper(II)
Fe^{2+}	2+	iron(II)
Fe^{3+}	3+	iron(III)
Al^{3+}	3+	aluminum

Common Anions (negative ions)

Formula	Charge	Name
F^-	1-	fluoride
Cl^-	1-	chloride
Br^-	1-	bromide
OH^-	1-	hydroxide
CH_3COO^-	1-	acetate
NO_3^-	1-	nitrate
O^{2-}	2-	oxide
S^{2-}	2-	sulfide
SO_4^{2-}	2-	sulfate
SO_3^{2-}	2-	sulfite
CO_3^{2-}	2-	carbonate
PO_4^{3-}	3-	phosphate

Names and Formulas of Some Ionic Compounds

- **Formulas of ionic compounds are determined by the charges of the ions.**
  - **Charge on the cations must equal the charge on the anions.**
  - **The compound must be neutral.**

- NaCl sodium chloride (Na^{1+} & Cl^{1-})
- KOH potassium hydroxide (K^{1+} & OH^{1-})
- $CaSO_4$ calcium sulfate (Ca^{2+} & SO_4^{2-})
- What about aluminum hydroxide?

Names and Formulas of Some Ionic Compounds

- To determine the Formula of an ionic compound, <u>you must</u> know the charge of the cation and anion. The relative numbers of the ions are adjusted by adding subscripts so that the total charge of all the ions added together is **ZERO**.

e.g. aluminum hydroxide

$Al^{3+} + 3OH^{-} \Rightarrow Al(OH)_3$

charge on ions: $(3+) + 3(1-) = 0$

Names and Formulas of Some Ionic Compounds

potassium sulfate

$2K^{+} + SO_4^{2-} \Rightarrow K_2SO_4$

charge on ions: 2(1+) + (2-) = 0

copper(II) nitrate

$Cu^{2+} + 2NO_3^{-} \Rightarrow Cu(NO_3)_2$

charge on ions (2+) + 2(1-) = 0

iron(II) phosphate

$3Fe^{2+} + 3PO_4^{3-} \Rightarrow Fe_3(PO_4)_2$

charge on ions 3(2+) + 2(3-) = 0

Names and Formulas of Some Ionic Compounds

- Table 2-2 gives names of several molecular compounds.
  - You must know all of the molecular compounds from Table 2-2.
- Some examples are:
  - H_2SO_4 - sulfuric acid
  - $FeBr_2$ - iron(II) bromide
  - C_2H_5OH - ethanol

Names and Formulas of Some Ionic Compounds

You do it!

- What is the formula of nitric acid?
- HNO_3
- What is the formula of sulfur trioxide?
- SO_3
- What is the name of $FeBr_3$?
- iron(III) bromide

Names and Formulas of Some Ionic Compounds

You do it!

- What is the name of K_2SO_3?
- potassium sulfite
- What is charge on sulfite ion?
- SO_3^{2-} is sulfite ion
- What is the formula of ammonium sulfide?
- $(NH_4)_2S$

Names and Formulas of Some Ionic Compounds

<u>***You do it!***</u>

- What is charge on ammonium ion?
- NH_4^{1+}
- What is the formula of aluminum sulfate?
- $Al_2(SO_4)_3$
- What is charge on both ions?
- Al^{3+} and SO_4^{2-}

Atomic Weights

- Scientists have put together a scale for comparing the masses of all the elements. The units are called amu (atomic mass units) or atomic weight (AW).

  1 amu = 1/12 mass of Carbon-12 atom.

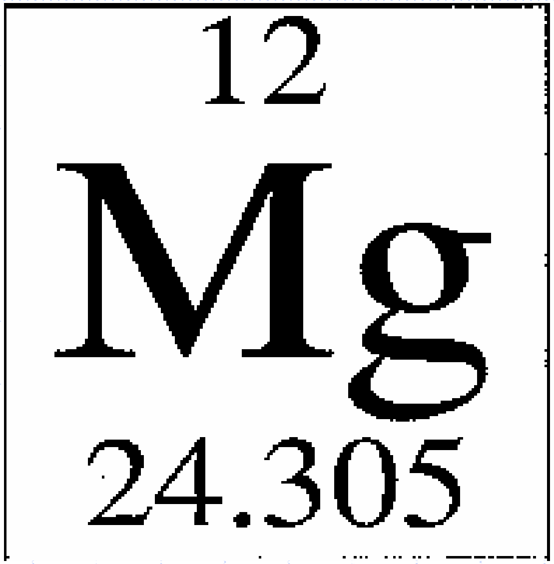
On this scale:
Atomic weight of H (weight of one atom): 1.0079 amu

Atomic weight of Na: 22.98977 amu
Na atom has 23 times more mass than the H atom

The periodic table lists the masses of all the known atoms in amu.

Atomic Weights

- Weighted average of the masses of the constituent isotopes if an element.
  - Tells us the atomic masses of every known element.
  - Lower number on periodic chart.
- How do we know what the values of these numbers are?



ISOTOPES

Isotopes are atoms of the same element (X) with different numbers of neutrons in their nuclei

Atomic number (Z) = number of protons in nucleus

Mass number (A) = number of protons + number of neutrons

= atomic number (Z) + number of neutrons

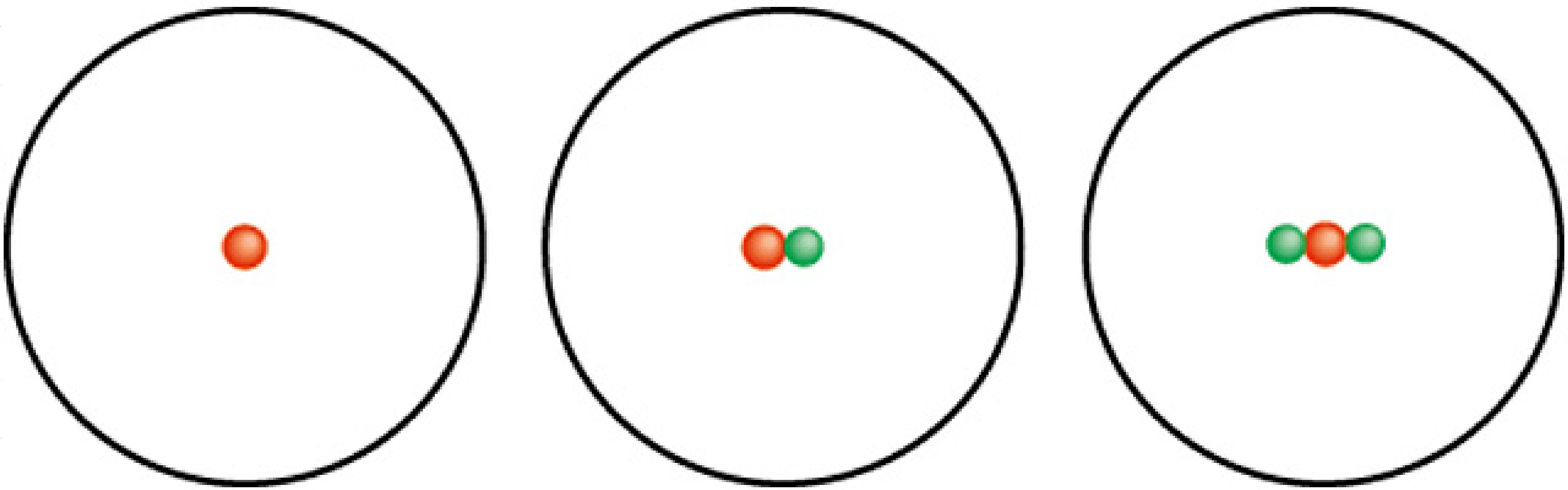
Atomic Number $\longrightarrow$ Z

Mass Number $\longrightarrow$ A

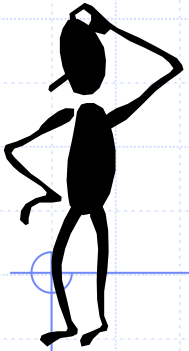
$${}^{Z}_{A}\mathrm{X} \longleftarrow \text{Element Symbol}$$

$${}^{1}_{1}\mathrm{H} \qquad {}^{1}_{2}\mathrm{H}\ (\mathrm{D}) \qquad {}^{1}_{3}\mathrm{H}\ (\mathrm{T})$$

$${}^{92}_{235}\mathrm{U} \qquad {}^{92}_{238}\mathrm{U}$$



$^{1}_{1}\mathrm{H}$ $^{2}_{1}\mathrm{H}$ $^{3}_{1}\mathrm{H}$



Do You Understand Isotopes?

How many protons, neutrons, and electrons are in ${}^{6}_{14}C$?

6 protons, 8 (14 - 6) neutrons, 6 electrons

How many protons, neutrons, and electrons are in ${}^{6}_{11}C$?

6 protons, 5 (11 - 6) neutrons, 6 electrons

The Mole

- A number of atoms, ions, or molecules that is large enough to see and handle.
- A mole = number of things
  - Just like a dozen = 12 things
  - One mole = 6.022×10^{23} things
- Avogadro's number = 6.022×10^{23}
  - Symbol for Avogadro's number is N_A.

The Mole

- How do we know when we have a mole?
  - count it out
  - weigh it out
- Molar mass - mass in grams numerically equal to the atomic weight of the element in grams.
- H has an atomic weight of 1.00794 g
  - 1.00794 g of H atoms = 6.022×10^{23} H atoms
- Mg has an atomic weight of 24.3050 g
  - 24.3050 g of Mg atoms = 6.022×10^{23} Mg atoms

The Mole

- Example 2-1: Calculate the mass of a single Mg atom in grams to 3 significant figures.

$$? \text{ g Mg} =$$

The Mole

- Example 2-1: Calculate the mass of a single Mg atom in grams to 3 significant figures.

$$? \text{ g Mg} = 1 \text{ Mg atom}$$

The Mole

- Example 2-1: Calculate the mass of a single Mg atom in grams to 3 significant figures.

$$? \text{ g Mg} = 1 \text{ Mg atom} \left(\frac{1 \text{ mol Mg atoms}}{6.022 \times 10^{23} \text{ Mg atoms}} \right) \times$$

The Mole

- Example 2-1: Calculate the mass of a single Mg atom, in grams, to 3 significant figures.

$$? \text{ g Mg} = 1 \text{ Mg atom} \left(\frac{1 \text{ mol Mg atoms}}{6.022 \times 10^{23} \text{ Mg atoms}} \right) \times$$

$$\left(\frac{24.30 \text{ g Mg}}{1 \text{ mol Mg atoms}} \right) = 4.04 \times 10^{-23} \text{ g Mg}$$

The Mole

- Example 2-2: Calculate the number of atoms in one-millionth of a gram of Mg to 3 significant figures.

$$? \text{ Mg atoms } =$$

The Mole

- Example 2-2: Calculate the number of atoms in one-millionth of a gram of Mg to 3 significant figures.

$$? \text{ Mg atoms} = 1.00 \times 10^{-6} \text{ g Mg} \left(\frac{1 \text{ mol Mg}}{24.30 \text{ g Mg}} \right)$$

The Mole

- Example 2-2: Calculate the number of atoms in one-millionth of a gram of Mg to 3 significant figures.

$$? \text{ Mg atoms} = 1.00 \times 10^{-6} \text{ g Mg} \left(\frac{1 \text{ mol Mg}}{24.30 \text{ g Mg}} \right) \left(\frac{6.022 \times 10^{23} \text{ Mg atoms}}{1 \text{ mol Mg atoms}} \right)$$

The Mole

- Example 2-2: Calculate the number of atoms in one-millionth of a gram of Mg to 3 significant figures.

$$? \text{ Mg atoms} = 1.00 \times 10^{-6} \text{ g Mg} \left(\frac{1 \text{ mol Mg}}{24.30 \text{ g Mg}} \right)$$

$$\left(\frac{6.022 \times 10^{23} \text{ Mg atoms}}{1 \text{ mol Mg atoms}} \right) = 2.48 \times 10^{16} \text{ Mg atoms}$$

The Mole

- Example 2-3. How many atoms are contained in 1.67 moles of Mg?

$$? \text{ Mg atoms} =$$

The Mole

- Example 2-3. How many atoms are contained in 1.67 moles of Mg?

$$? \text{ Mg atoms} = 1.67 \text{ mol Mg}$$

The Mole

- Example 2-3. How many atoms are contained in 1.67 moles of Mg?

$$? \text{ Mg atoms} = 1.67 \text{ mol Mg}\left(\frac{6.022\times10^{23} \text{ Mg atoms}}{1 \text{ mol Mg}}\right)$$

The Mole

- Example 2-3. How many atoms are contained in 1.67 moles of Mg?

$$? \text{ Mg atoms} = 1.67 \text{ mol Mg} \left(\frac{6.022 \times 10^{23} \text{ Mg atoms}}{1 \text{ mol Mg}} \right)$$

$$= 1.00 \times 10^{24} \text{ Mg atoms}$$

The Mole

- Example 2-4: How many moles of Mg atoms are present in 73.4 g of Mg?

You do it!

The Mole

- Example 2-4: How many moles of Mg atoms are present in 73.4 g of Mg?

$$? \, \text{mol Mg} = 73.4 \, \text{g Mg}$$

The Mole

- Example 2-4: How many moles of Mg atoms are present in 73.4 g of Mg?

$$? \text{ mol Mg} = 73.4 \text{ g Mg} \left(\frac{1 \text{ mol Mg atoms}}{24.30 \text{ g Mg}} \right)$$

The Mole

- Example 2-4: How many moles of Mg atoms are present in 73.4 g of Mg?

$$? \text{ mol Mg} = 73.4 \text{ g Mg}\left(\frac{1 \text{ mol Mg atoms}}{24.30 \text{ g Mg}}\right)$$

$$= 3.02 \text{ mol Mg}$$

IT IS IMPERATIVE THAT YOU KNOW HOW TO DO THESE PROBLEMS

Formula Weights, Molecular Weights, and Moles

- How do we calculate the molar mass of a compound?
  - add atomic weights of each atom
- The molar mass of propane, C_3H_8, is:

$$
\begin{aligned}
3 \times \mathrm{C} = 3 \times 12.01\,\mathrm{amu} &= 36.03\,\mathrm{amu} \\
8 \times \mathrm{H} = 8 \times \ \ 1.01\,\mathrm{amu} &= \ \ 8.08\,\mathrm{amu} \\
\hline
\text{Molar mass} &= 44.11\,\mathrm{amu}
\end{aligned}
$$

Formula Weights, Molecular Weights, and Moles

- The molar mass of calcium nitrate, $Ca(NO_3)_2$, is:

You do it!

Formula Weights, Molecular Weights, and Moles

$$
\begin{aligned}
1\times \text{Ca} &= 1\times 40.08\ \text{amu} = 40.08\ \text{amu}\\
2\times \text{N} &= 2\times 14.01\ \text{amu} = 28.02\ \text{amu}\\
6\times \text{O} &= 6\times 16.00\ \text{amu} = 96.00\ \text{amu}\\
\hline
\text{Molar mass} &= 164.10\ \text{amu}
\end{aligned}
$$

Formula Weights, Molecular Weights, and Moles

- One Mole of Contains
  - Cl_2 or 70.90g — 6.022×10^{23} Cl_2 molecules
    - $2(6.022 \times 10^{23})$ Cl atoms
  - C_3H_8 *You do it!*

Formula Weights, Molecular Weights, and Moles

One Mole of	Contains
Cl_2 or 70.90g	6.022×10^{23} Cl_2 molecules
	$2(6.022 \times 10^{23})$ Cl atoms
C_3H_8 or 44.11 g	6.022×10^{23} C_3H_8 molecules
	$3(6.022 \times 10^{23})$ C atoms
	$8(6.022 \times 10^{23})$ H atoms

Formula Weights, Molecular Weights, and Moles

- Example 2-5: Calculate the number of C_3H_8 molecules in 74.6 g of propane.

$$? \ \mathrm{C_3H_8\ molecules} = 74.6\ \mathrm{g\ C_3H_8} \times$$

Formula Weights, Molecular Weights, and Moles

- Example 2-5: Calculate the number of C_3H_8 molecules in 74.6 g of propane.

$$? \ C_3H_8 \text{ molecules} = 74.6 \text{ g } C_3H_8 \times \left(\frac{1 \text{ mole } C_3H_8}{44.11 \text{ g } C_3H_8} \right)$$

Formula Weights, Molecular Weights, and Moles

- Example 2-5: Calculate the number of C_3H_8 molecules in 74.6 g of propane.

$$? \, C_3H_8 \text{ molecules} = 74.6 \, \text{g} \, C_3H_8 \times$$

$$\left(\frac{1 \, \text{mole} \, C_3H_8}{44.11 \, \text{g} \, C_3H_8}\right)\left(\frac{6.022 \times 10^{23} \, C_3H_8 \text{ molecules}}{44.11 \, \text{g} \, C_3H_8}\right) =$$

Formula Weights, Molecular Weights, and Moles

- Example 2-5: Calculate the number of C_3H_8 molecules in 74.6 g of propane.

$$? \ C_3H_8 \text{ molecules} = 74.6 \text{ g } C_3H_8 \times$$

$$\left(\frac{1 \text{ mole } C_3H_8}{44.11 \text{ g } C_3H_8}\right)\left(\frac{6.022 \times 10^{23} \ C_3H_8 \text{ molecules}}{44.11 \text{ g } C_3H_8}\right) =$$

$$1.02 \times 10^{24} \text{ molecules}$$

Formula Weights, Molecular Weights, and Moles

- Example 2-8. Calculate the number of O atoms in 26.5 g of Li_2CO_3.

<u>You do it!</u>

Formula Weights, Molecular Weights, and Moles

- Example 2-8. Calculate the number of O atoms in 26.5 g of Li_2CO_3.

$$? \text{ O atoms} = 26.5 \text{ g } Li_2CO_3 \times \frac{1 \text{ mol } Li_2CO_3}{73.8 \text{ g } Li_2CO_3} \times$$

$$\frac{6.022 \times 10^{23} \text{ form.units } Li_2CO_3}{1 \text{ mol } Li_2CO_3} \times \frac{3 \text{ O atoms}}{1 \text{ formula unit } Li_2CO_3} =$$

$$6.49 \times 10^{23} \text{ O atoms}$$

Formula Weights, Molecular Weights, and Moles

- Occasionally, we will use millimoles.
  - Symbol - mmol
  - 1000 mmol = 1 mol
- For example: oxalic acid $(COOH)_2$
  - 1 mol = 90.04 g
  - 1 mmol = 0.09004 g or 90.04 mg

Formula Weights, Molecular Weights, and Moles

- Example 2-9: Calculate the number of mmol in 0.234 g of oxalic acid, $(COOH)_2$.

You do it!

Formula Weights, Molecular Weights, and Moles

- Example 2-9: Calculate the number of mmol in 0.234 g of oxalic acid, $(COOH)_2$.

$$? \text{ mmol} (COOH)_2 = 0.234 \text{ g} (COOH)_2 \times$$

$$\left(\frac{1 \text{ mmol} (COOH)_2}{0.09004 \text{ g} (COOH)_2} \right) = 2.60 \text{ mmol} (COOH)_2$$

Percent Composition and Formulas of Compounds

- % composition = mass of an individual element in a compound divided by the total mass of the compound x 100%
- Determine the percent composition of C in C_3H_8.

$$\%\ \mathrm{C} = \frac{\text{mass C}}{\text{mass } \mathrm{C_3H_8}} \times 100\%$$

$$= \frac{3 \times 12.01\ \mathrm{g}}{44.11\ \mathrm{g}} \times 100\%$$

$$= 81.68\%$$

Percent Composition and Formulas of Compounds

- What is the percent composition of H in C_3H_8?

<u>You do it!</u>

Percent Composition and Formulas of Compounds

- What is the percent composition of H in C_3H_8?

$$\% \text{ H} = \frac{\text{mass H}}{\text{mass } C_3H_8} \times 100\%$$

$$= \frac{8 \times \text{H}}{C_3H_8} \times 100\%$$

$$= \frac{8 \times 1.01 \text{ g}}{44.11 \text{ g}} \times 100\% = 18.32\ \%$$

or

$$18.32\% = 100\% - 81.68\%$$

Percent Composition and Formulas of Compounds

- Example 2-10: Calculate the percent composition of $Fe_2(SO_4)_3$ to 3 significant figures.

  <u>You do it!</u>

Percent Composition and Formulas of Compounds

- Example 2-10: Calculate the percent composition of $Fe_2(SO_4)_3$ to 3 sig. fig.

$$\% \text{ Fe} = \frac{2\times \text{Fe}}{\text{Fe}_2(\text{SO}_4)_3}\times 100\% = \frac{2\times 55.8\text{ g}}{399.9\text{ g}}\times 100\% = 27.9\% \text{ Fe}$$

$$\% \text{ S} = \frac{3\times \text{S}}{\text{Fe}_2(\text{SO}_4)_3}\times 100\% = \frac{3\times 32.1\text{ g}}{399.9\text{ g}}\times 100\% = 24.1\% \text{ S}$$

$$\% \text{ O} = \frac{12\times \text{O}}{\text{Fe}_2(\text{SO}_4)_3}\times 100\% = \frac{12\times 16.0\text{ g}}{399.9\text{ g}}\times 100\% = 48.0\% \text{ O}$$

$$\text{Total} \qquad = 100\%$$

Determination of Molecular Formulas

- Example 2-13: A compound is found to contain 85.63% C and 14.37% H by mass. In another experiment its molar mass is found to be 56.1 g/mol. What is its molecular formula?
  - short cut method

$$1 \text{ mol contains } 56.1 \text{ g}$$

$$85.63\% \text{ is C and } 14.37\% \text{ is H}$$

$$56.1 \text{ g} \times 0.8563 = 48.0 \text{ g of C}$$

$$56.1 \text{ g} \times 0.1437 = 8.10 \text{ g of H}$$

Determination of Molecular Formulas

$$\underline{\underline{\text{convert masses to moles}}}$$

$$48.0 \text{ g of C} \times \frac{1 \text{ mol C}}{12.0 \text{ g C}} = 4 \text{ mol C}$$

$$8.10 \text{ g of H} \times \frac{1 \text{ mol H}}{1.01 \text{ g H}} = 8 \text{ mol H}$$

Thus the formula is :

$$C_4H_8$$

Some Other Interpretations of Chemical Formulas

- Example 2-16: What mass of ammonium phosphate, $(NH_4)_3PO_4$, would contain 15.0 g of N?

$$\text{molar mass of } (\text{NH}_4)_3\text{PO}_4 = 149.0 \text{ g/mol}$$

$$? \text{ mol N} = 15.0 \text{ g of N} \times \frac{1 \text{ mol N}}{14.0 \text{ g N}} = 1.07 \text{ mol N}$$

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$$1.07 \text{ mol N} \times \frac{1 \text{ mol } (\text{NH}_4)_3\text{PO}_4}{3 \text{ mol N}} = 0.357 \text{ mol } (\text{NH}_4)_3\text{PO}_4$$

Purity of Samples

- The percent purity of a sample of a substance is always represented as

$$\%\ \text{purity} = \frac{\text{mass of pure substance}}{\text{mass of sample}} \times 100\%$$

$$\text{mass of sample includes impurities}$$

Purity of Samples

- Example 2-18: A bottle of sodium phosphate, Na_3PO_4, is 98.3% pure Na_3PO_4. What are the masses of Na_3PO_4 and impurities in 250.0 g of this sample of Na_3PO_4?

$$\text{unit factor} \quad \frac{98.3\ \text{g Na}_3\text{PO}_4}{100.0\ \text{g sample}}$$

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$$?\text{ g } Na_3PO_4 = 250.0\text{ g sample} \times \frac{98.3\text{ g } Na_3PO_4}{100.0\text{ g sample}}$$

$$= 246\text{ g } Na_3PO_4$$

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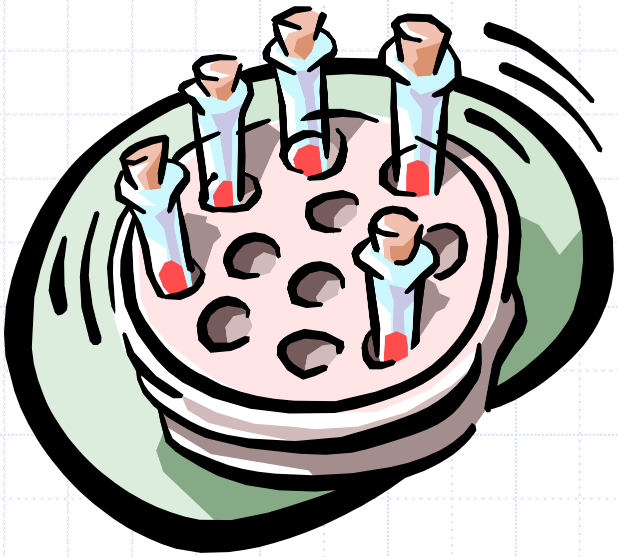
$$= 246\ \text{g}\ Na_3PO_4$$

$$?\ \text{g impurities} = 250.0\ \text{g sample} - 246\ \text{g}\ Na_3PO_4$$

$$= 4.00\ \text{g impurities}$$

End of Chapter 2

- The mole concept and basic stoichiometry ideas introduced in this chapter are essential components for the remainder of this course.



Homework Assignment

Textbook Problems **(optional, Chapter 2):**

2, 3, 6, 13, 14, 17, 25, 29, 35, 38, 40, 46, 47, 49, 62, 68, 74, 104

One-line Web Learning (OWL):

Chapter 2 Exercises and Tutors – Required

Due by 02/08.