CHM 123 – Lecture 2 (Friday 10:30 am)

Chapter 3 – Chemical compounds

Molecular compounds – molecular formulas

- Molecular formula gives the exact number of atoms in a compound.

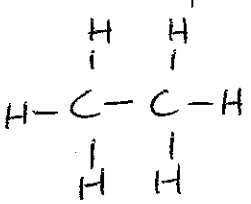
- Inorganic compounds:
  - do not contain carbon. e.g. $PbSO_4$, NaCl (salts).
  - Ionic
- Organic compounds:
  - contain carbon.
  - generally molecules.

Writing formulas:

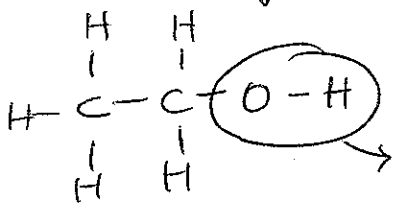
(A) Molecular formula – group the carbon, hydrogen, oxygen atoms together.

C_2H_6 ethane $\qquad$ C_2H_6O ethanol

(B) Structural formula – shows bonding



ethane



~~structural~~ functional group.

(C) Condensed formula

CH_3CH_3 ethane $\qquad$ CH_3CH_2OH ethanol.

Naming of Binary Inorganic Compounds

- Molecules containing atoms of only 2 elements.
- look at table in textbook.

Compounds with common non-systematic names:

- p 82 in textbook.

e.g. H_2O - water not dihydrogen oxide.
NH_3 - ammonia
PH_3 - phosphine

Hydrocarbons

- contain only carbon and hydrogen
- simplest class is alkanes - general formula C_nH_{2n+2}, where n = # of carbons.
- when $n=1$, CH_4 ⇒ methane
  $n=2$, C_2H_6 - ethane
  $n=3$, C_3H_8 - propane
  $n=4$, C_4H_{10} - butane
  $n=5$, C_5H_{12} - pentane
  - hexane
  ⋮

Ions and ionic compounds

- Ionic compound is composed of positive and negative ions.
- Typically a combination of metal with non metal.
- Metals lose electrons to form cations (positively charged)
- Non metals gain electrons to form anions (negatively charged)

Ionic Charges

Ultimate goal of an element is to have the electronic configuration of a noble gas.

- All elements in grp 1A (sodium, potassium) lose 1 electron to acquire the electron configuration of He, Ne etc. Group 1A elements form Na^+, K^+ ions.
- group 7 elements gain an electron to have same number of electrons as respective noble gases.

Ionic compounds

- Cation is written first, followed by anion.

e.g. $Na^+ + Cl^- \longrightarrow NaCl$

$Ca^{2+} + Cl^- \longrightarrow CaCl_2$

Naming of Ionic compounds

- Cations:

Na^+ sodium ion

Ca^{2+} calcium ion

Fe^{2+} iron (II) ion

NH_4^+ ammonium ion (ammonia replaced with 'ium')

H_3O^+ (hydronium ion from water).

- Anions

- For polyatomic ions, smaller number of oxygens results in suffix 'ite'. larger number of oxygens results in 'ate' suffix.

e.g. NO_3^- nitrate NO_2^- nitrite

SO_4^{2-} sulfate SO_3^{2-} sulfite.

- Monoatomic ions:
  - F^- fluoride
  - Cl^- chloride
  - H^- hydride
  - S^{2-} sulfide

Polyatomic ions with non systematic names:

(a) Acetate ion CH_3COO^-
(b) Cyanide CN^-
(c) Hydroxide OH^-
(d) peroxide O_2^{2-}
(e) superoxide O_2^-
(f) permanganate MnO_4^-
(g) chromate CrO_4^{2-}
(h) dichromate $Cr_2O_7^{2-}$

Properties of ionic compounds

- Crystalline
- Hard, brittle
- High melting + boiling points
- Electrolytes when aqueous or molten.
- Metal + nonmetal.

Percent composition

- $\frac{\text{Mass of an element}}{\text{Mass of the compound}} \times 100$
- e.g. sucrose, ~~$C_{12}H_{22}O_{11}$~~ $C_{12}H_{22}O_{11}$

$$\%\text{ of carbon} = \text{~~no. atoms of C~~} \times \left[\frac{\text{Mass of carbon } (12 \times 12.01 \leftarrow \text{atomic wt. of carbon})}{\text{Mass of compound } (12\times12.01 + 22\times1.098 + 11\times15.98)}\right] \times 100$$

Obtaining empirical formulas:

Mass % of element $\xrightarrow{\text{assume 100g of sample}}$ grams of each element $\xrightarrow[\text{wt of element}]{\text{Atomic}}$ Moles of each element $\xrightarrow{\text{divide by smallest \# of moles}}$ emp formula

Molecular formula from Empirical formula

- Calculate molar mass of empirical formula.
- Give the actual molar mass, divide $\frac{\text{Actual molar mass}}{\text{Molar mass of Emp. formula}}$
- Using number obtained in step 2, multiply empirical formula by this number to determine molecular formula.