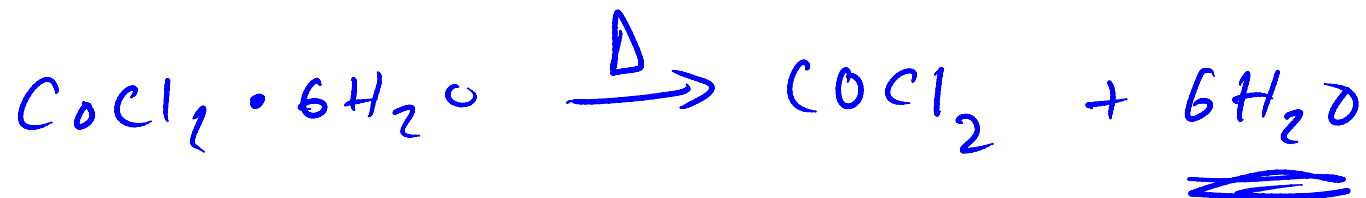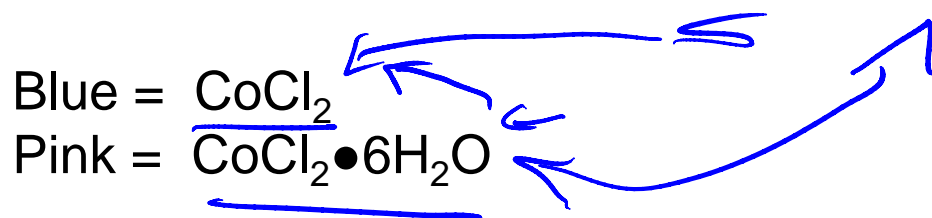# Chem 111

Lecture 7

Homework

- Continue Reading Chapter 3

- OWL online homework.

Recap

- Mole

- Molar Mass

- Formula weight

- Percent Composition

- Getting empirical formula

Hydrates/ Solvated Crystals

Often times when you get a compound the solvent will get trapped in the lattice.

Blue = $CoCl_2$
Pink = $CoCl_2 \bullet 6H_2O$

$$CoCl_2 \cdot 6H_2O \xrightarrow{\Delta} CoCl_2 + 6H_2O$$

Let's Practice

Calculate the percentage of nitrogen (by mass) in $Ca(NO_3)_2$.

$$1 \text{ Ca atom} = 40.1 \text{ u}$$
$$2 \text{ N atoms} = 28.0 \text{ u}$$
$$6 \text{ O atoms} = \frac{96.0 \text{ u}}{164.1 \text{ u}}$$

$$\% N = \frac{(2)(14.0 \text{ u})}{164.1 \text{ u}} \times 100 = 17.1\%$$

Let's Practice

Calculate the number of C atoms in 0.350 mol of $C_6H_{12}O_6$

$$0.350 \text{ mol } C_6H_{12}O_6 \left(\frac{6.022 \times 10^{23} \text{ molecules}}{1 \text{ mol } C_6H_{12}O_6} \right) \left(\frac{6 \text{ atoms C}}{1 \text{ molecule } C_6H_{12}O_6} \right)$$
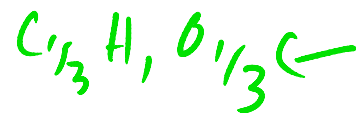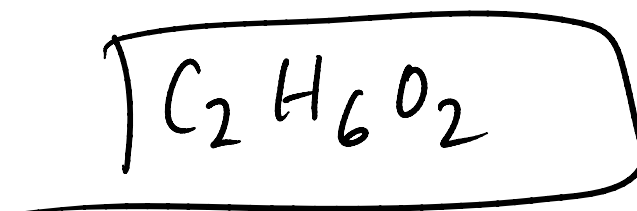
$$1.26 \times 10^{24} \text{ atoms C}$$

Let's Practice

Anti-freeze, ethylene glycol, is composed of 38.7% carbon, 9.7% hydrogen and 51.6% oxygen by mass. Its molar mass is 62.1 g/mol. What is its molecular formula?

$$CH_3O = (12.0u) + 3(1.0u) + (16.0u) = 31.0u$$

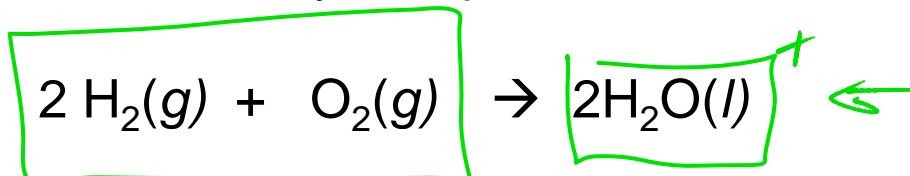$$62.1 \text{ g/mol} \div 31 = 2x$$

$C_{1/3} H_1 O_{1/3}$

$$\boxed{C_2 H_6 O_2}$$

$$C: \frac{3.23 \text{ mol}}{3.23 \text{ mol}} = 1 \quad ^1/_3 \quad H: \frac{9.7}{3.23} = 3 \quad 1 \quad O: \frac{3.23}{3.23} = 1 \quad ^1/_3$$

$$^1/_8 \quad C_1 H_3 O_1 \Rightarrow \boxed{CH_3 O}$$

Chemical Equations

Concise way to represent chemical reactions.

$$2\ H_2(g)\ +\ O_2(g)\ \rightarrow\ 2H_2O(l)$$

"+" = reacts with
→ = produces
Left of arrow = reactants
Right of arrow = products

Physical State
(g) = gas
(l) = liquid
(s) = solid
(aq) = aqueous

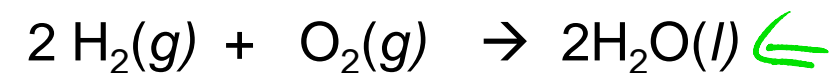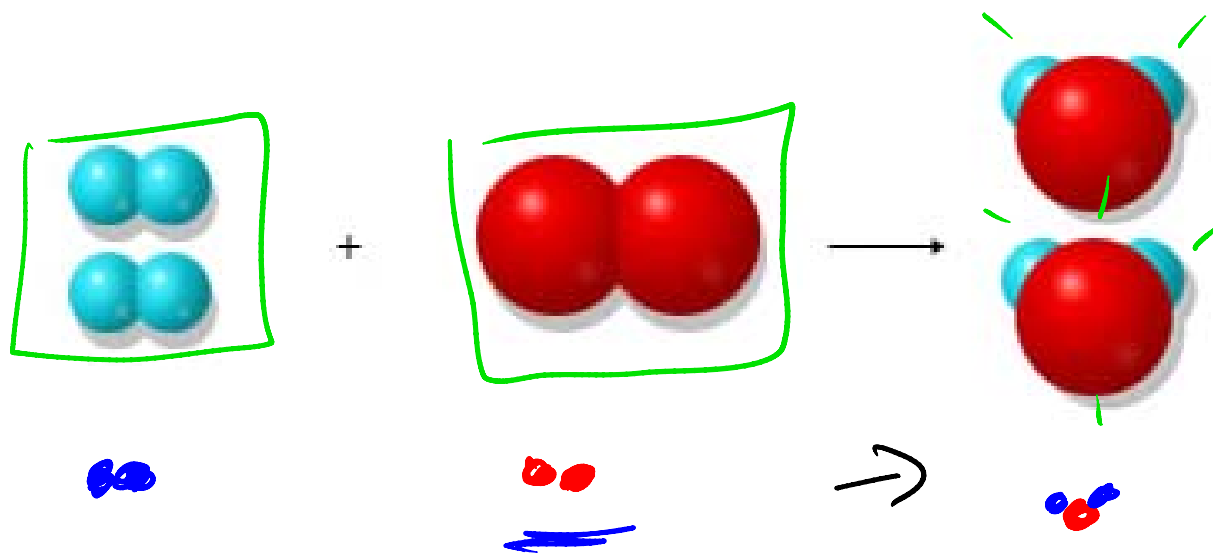(THF)   THF

(eth) = etherate

Balanced Chemical Equations

$2 H_2(g) + O_2(g) \rightarrow 2H_2O(l)$

$H_2 + O_2 \rightarrow H_2O$

In normal chemical reactions (non-nuclear) atoms are neither created nor destroyed. An equal number of atoms of each type are found on both sides of the equation.

Stoichiometry – the quantative relationship between products and reactants
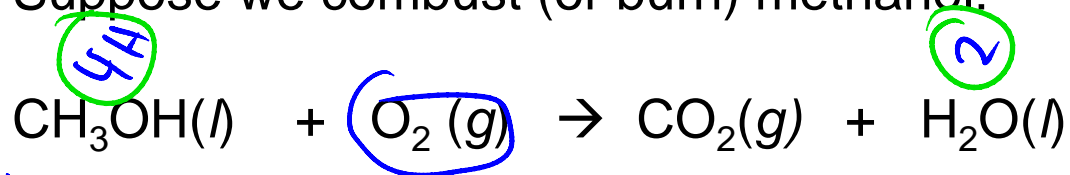
Combustion reactions

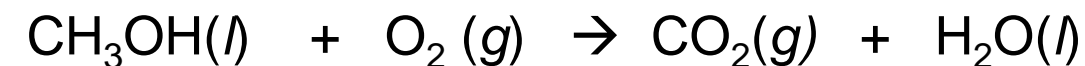Most reaction involve combining O_2 from air with a reactant.
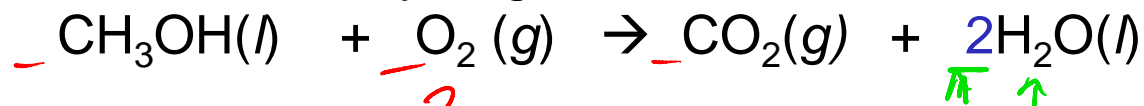When hydrocarbons are combusted they form CO_2 + H_2O.   CHO
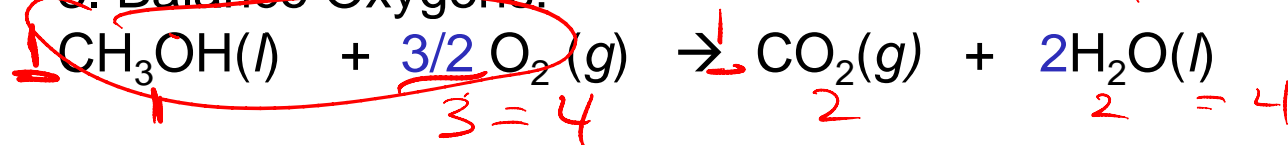Suppose we combust (or burn) methanol:

$CH_3OH(l)$ + $O_2(g)$ → $CO_2(g)$ + $H_2O(l)$

1. Balance Carbons:
$CH_3OH(l)$ + $O_2(g)$ → $CO_2(g)$ + $H_2O(l)$

2. Balance Hydrogens:
$CH_3OH(l)$ + $O_2(g)$ → $CO_2(g)$ + $2H_2O(l)$ H$_4$O

3. Balance Oxygens:
$CH_3OH(l)$ + $3/2\ O_2(g)$ → $CO_2(g)$ + $2H_2O(l)$
3 = 4   2   2 = 4

4. Remove Fractional Coefficients
$2\,CH_3OH(l)$ + $3O_2(g)$ → $2\,CO_2(g)$ + $4\,H_2O(l)$
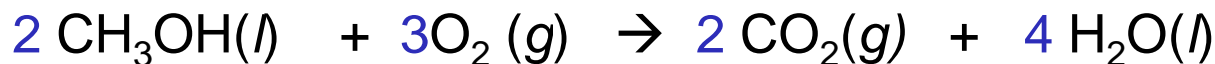
Chemical Equilibrium

Chemical Equilibrium – occurs when opposing reactions are proceeding at the same rate.

N_2O_4 (*g*) → $2NO_2$(*g*)
$2NO_2$ (*g*) → N_2O_4 (*g*)

$$N_2O_4(g) \rightleftharpoons 2\,NO_2(g)$$

Colorless   Brown
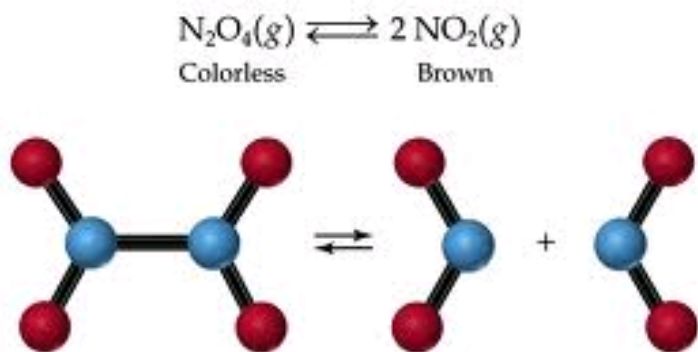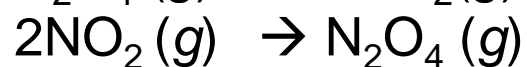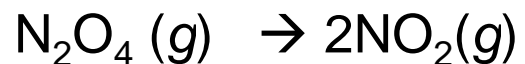
Solutions

Solution – is a homogeneous mixture of two or more substances.

Solvent - is the component that is present in greater quantity.

Solute - is the component that is present in lesser quantity. It is said to be dissolved in the solvent.

Aqueous Solutions – Solutions where water is the solvent.
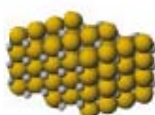
Aqueous Solutions

Electrolyte – a substance whose aqueous solutions contains ions and hence conduct electricity.

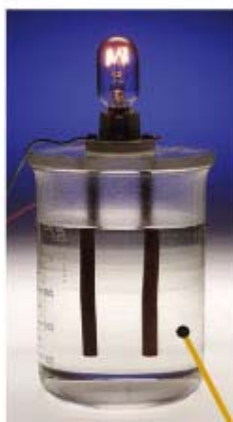**Non electrolyte -** a substance that does not form ions in solution.
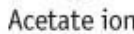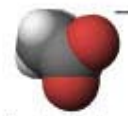

Strong Electrolyte

A **strong electrolyte** conducts electricity. $CuCl_2$ is completely dissociated into Cu^{2+} and Cl^- ions.
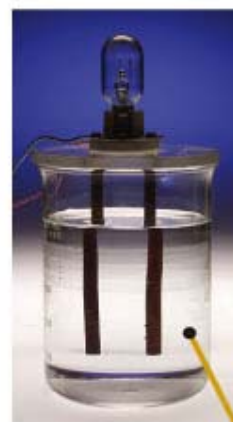
$CuCl_2$

Cu^{2+}

Cl^-

Weak Electrolyte

A **weak electrolyte** conducts electricity poorly because only a few ions are present in solution.
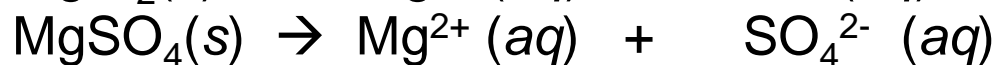
Acetic acid

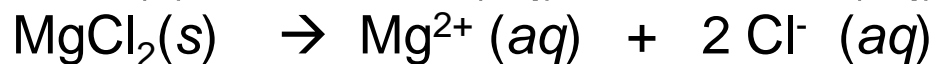Acetate ion
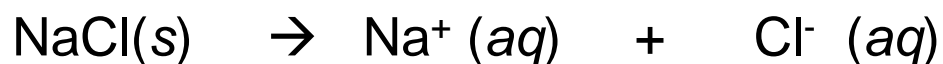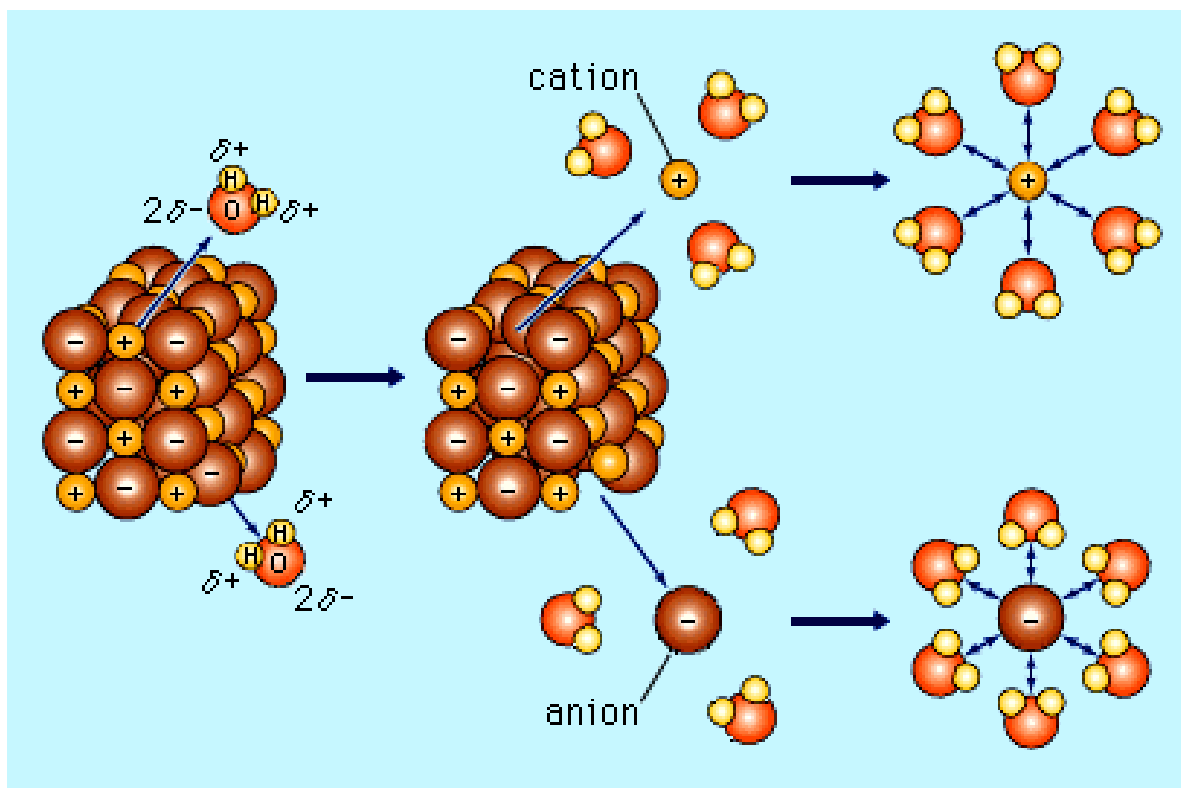
H^+

Nonelectrolyte

A **nonelectrolyte** does not conduct electricity because no ions are present in solution.

Ethanol

Ionic Compounds in Water

Water is a polar solvent.

$NaCl(s) \rightarrow Na^+ (aq) + Cl^- (aq)$

$MgCl_2(s) \rightarrow Mg^{2+} (aq) + 2\,Cl^- (aq)$

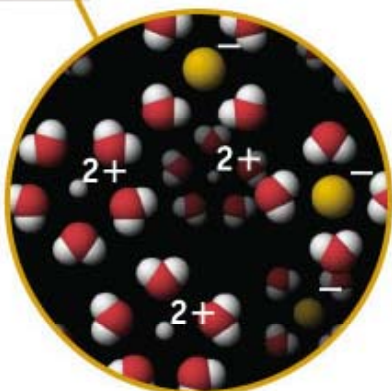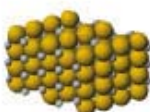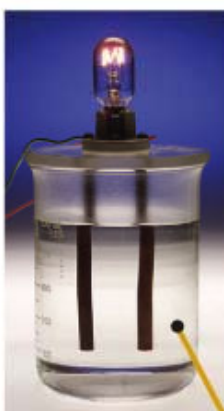$MgSO_4(s) \rightarrow Mg^{2+} (aq) + SO_4^{2-} (aq)$

Ionic Compounds in Water

Strong Electrolyte

A **strong electrolyte** conducts electricity. $CuCl_2$ is completely dissociated into Cu^{2+} and Cl^- ions.
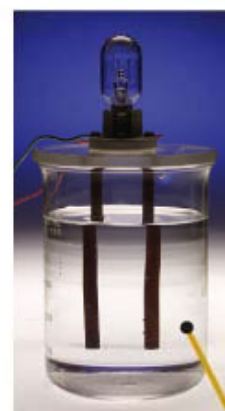
$CuCl_2$

Cu^{2+} 2+

Cl^- —

Weak Electrolyte

A **weak electrolyte** conducts electricity poorly because only a few ions are present in solution.
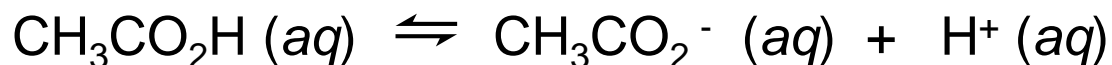
Acetic acid

Acetate ion —

H^+ +

Nonelectrolyte

A **nonelectrolyte** does not conduct electricity because no ions are present in solution.

Ethanol
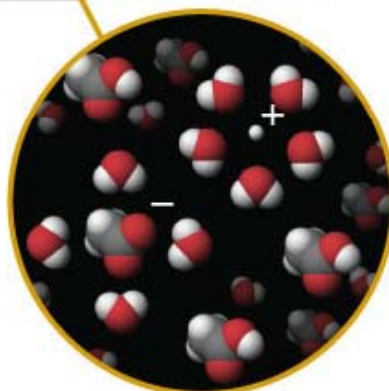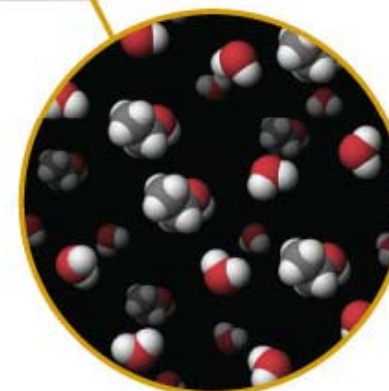
© Brooks/Cole, Cengage Learning

$$CH_3CO_2H \ (aq) \ \rightleftharpoons \ CH_3CO_2^- \ (aq) \ + \ H^+ \ (aq)$$

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Solubility

SOLUBLE COMPOUNDS	EXCEPTIONS
Almost all salts of Na^+, K^+, NH_4^+	
Salts of nitrate, NO_3^- chlorate, ClO_3^- perchlorate, ClO_4^- acetate, $CH_3CO_2^-$	
Almost all salts of Cl^-, Br^-, I^-	Halides of Ag^+, Hg_2^{2+}, Pb^{2+}
Salts containing F^-	Fluorides of Mg^{2+}, Ca^{2+}, Sr^{2+}, Ba^{2+}, Pb^{2+}
Salts of sulfate, SO_4^{2-}	Sulfates of Ca^{2+}, Sr^{2+}, Ba^{2+}, Pb^{2+}

INSOLUBLE COMPOUNDS	EXCEPTIONS
Most salts of carbonate, CO_3^{2-} phosphate, PO_4^{3-} oxalate, $C_2O_4^{2-}$ chromate, CrO_4^{2-} sulfide, S^{2-}	Salts of NH_4^+ and the alkali metal cations
Most metal hydroxides and oxides	Alkali metal hydroxides and $Ba(OH)_2$

Fig. 3-10, p. 126