Chem 111

Lecture 5

Homework

- Finishing Up Reading Chapter 2
- OWL online homework.

Recap

- Periodic Table
- Molecules
- Chemical Formulas

Formulas

Condensed formula – show atoms in relation (how they are grouped) to each other without showing the bonds.

Structural formula – is a graphical depiction of the molecular structure.

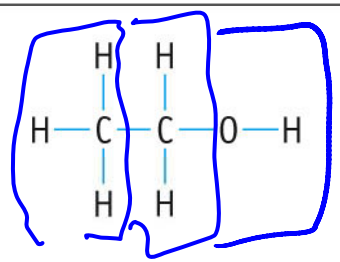
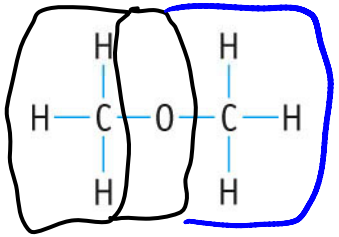
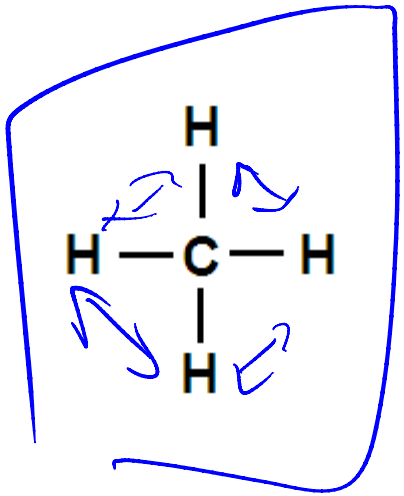
NAME	MOLECULAR FORMULA	CONDENSED FORMULA	STRUCTURAL FORMULA
Ethanol	C_2H_6O	CH_3CH_2OH	
Dimethyl ether	C_2H_6O	CH_3OCH_3	

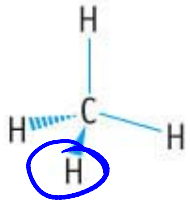
Fig. 2-13, p. 68

Models

Methane

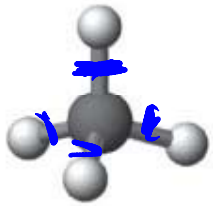
CH_4



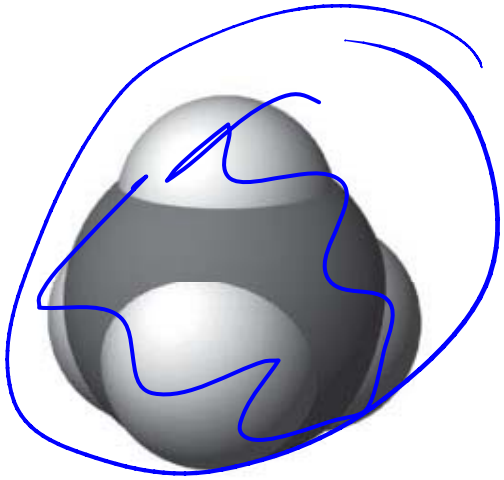


Simple perspective drawing

Plastic model



Ball-and-stick model

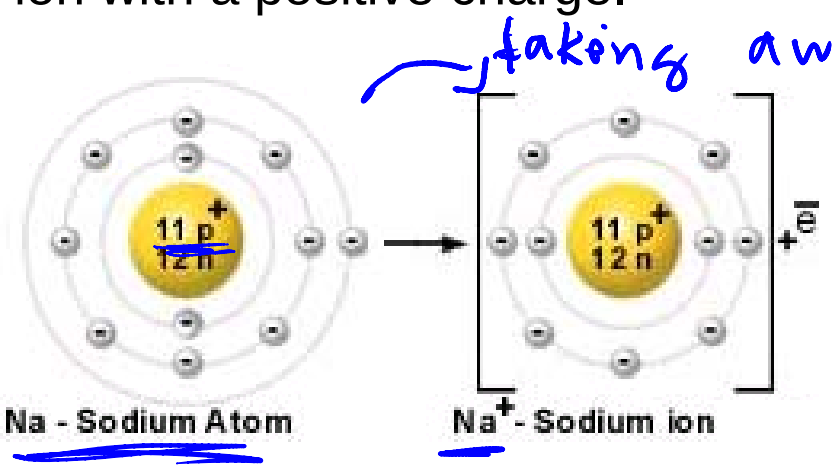


Space-filling model

Ions

Ions – are charged particles. Occur when electrons are removed or added to a neutral atom or molecule.

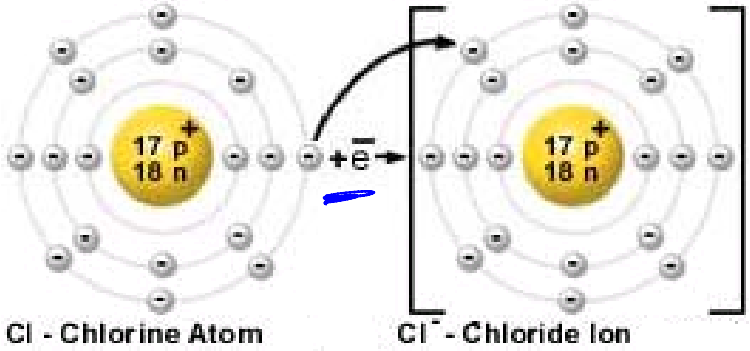
Cation – an ion with a positive charge.



taking away e⁻

11+
10−
1+

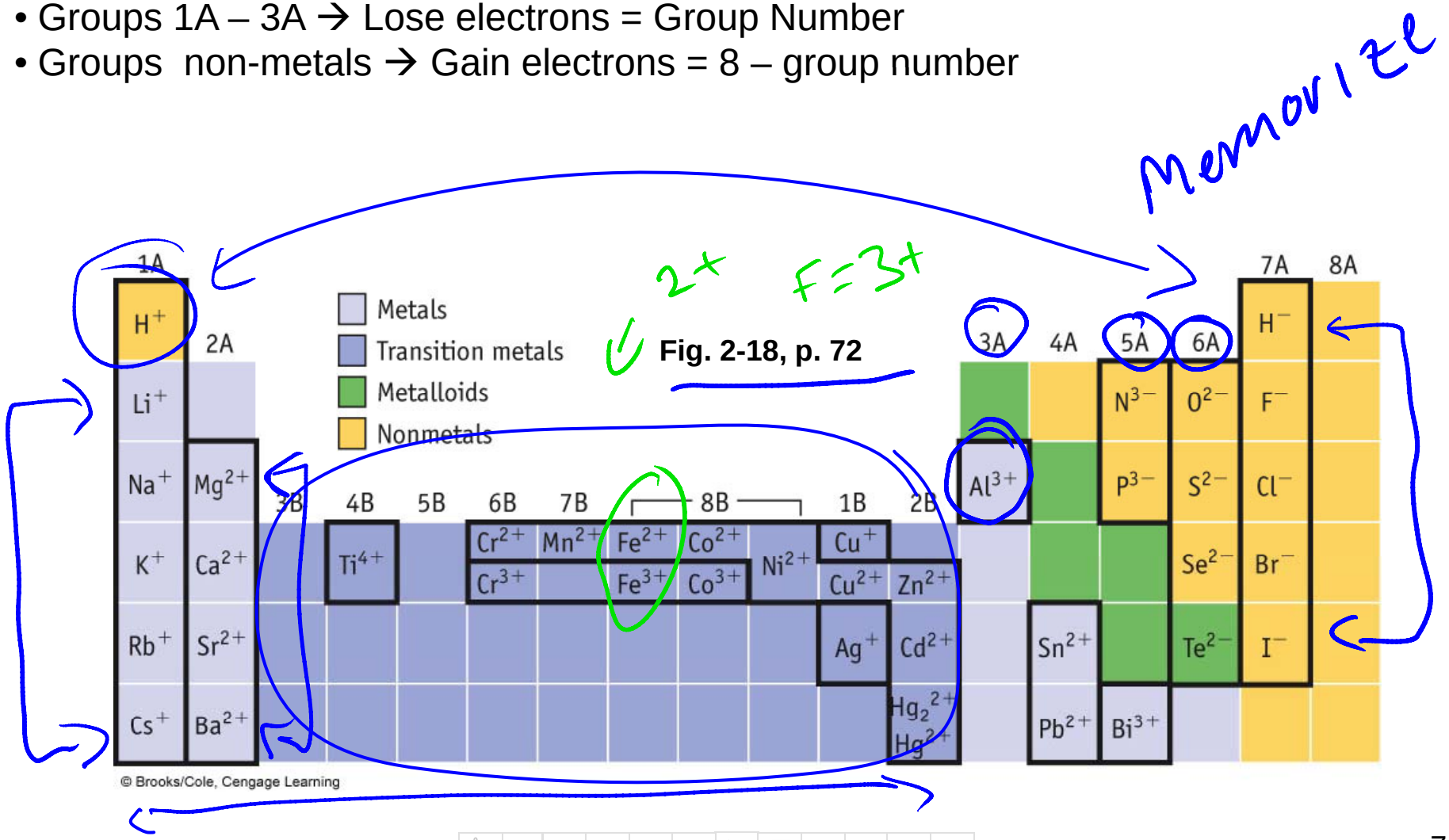
Anion – an ion with a negative charge.



17+
18e⁻
1−

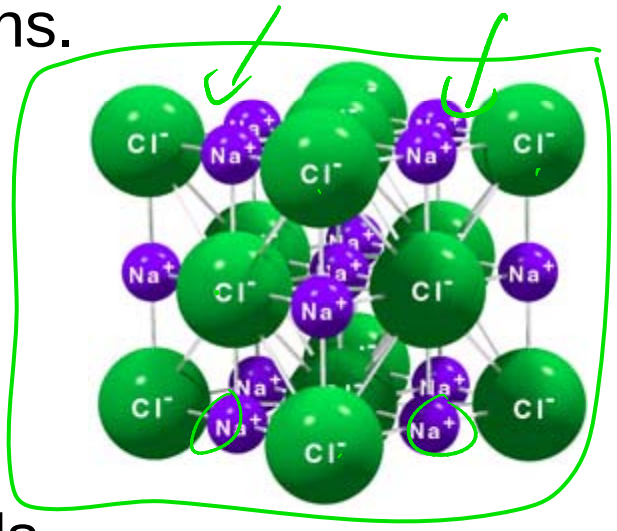
Monatomic Ions

- Metals generally lose electrons and form cations.
- Nonmetals generally gain electrons and form anions.
- Groups 1A – 3A → Lose electrons = Group Number
- Groups non-metals → Gain electrons = 8 – group number



Ionic Compounds = metal + non-metal

Ionic Compounds - are compounds that contain positively charged ions and negatively charged ions.



$Na \rightarrow Na^+ + e^-$

$Cl + e^- \rightarrow Cl^-$

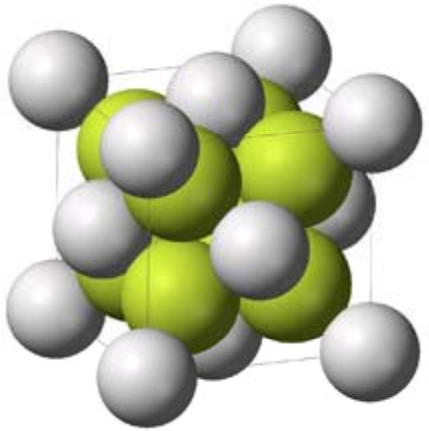
$Na^+ + Cl^- \rightarrow NaCl$

Metals + Nonmetals → Ionic Compounds

$Ca \rightarrow Ca^{2+} + 2e^-$

$F + e^- \rightarrow F^-$

$Ca^{2+} + 2F^- \rightarrow CaF_2$ $[CaF]^{+1}$



Polyatomic Ions

Polyatomic Ion - is a charged compound composed of two or more atoms bonded together.

TABLE 2.4 Formulas and Names of Some Common Polyatomic Ions

Formula	Name	Formula	Name
CATION: Positive Ion			
NH_4^+	ammonium ion		
ANIONS: Negative Ions			
Based on a Group 4A element		**Based on a Group 7A element**	
CN^-	cyanide ion	ClO^-	hypochlorite ion
$CH_3CO_2^-$	acetate ion	ClO_2^-	chlorite ion
CO_3^{2-}	carbonate ion	ClO_3^-	chlorate ion
HCO_3^-	hydrogen carbonate ion (or bicarbonate ion)	ClO_4^-	perchlorate ion
Based on a Group 5A element		**Based on a Group 6A element**	
NO_2^-	nitrite ion	OH^-	hydroxide ion
NO_3^-	nitrate ion	SO_3^{2-}	sulfite ion
PO_4^{3-}	phosphate ion	SO_4^{2-}	sulfate ion
HPO_4^{2-}	hydrogen phosphate ion	HSO_4^-	hydrogen sulfate ion (or bisulfate ion)
$H_2PO_4^-$	dihydrogen phosphate ion		

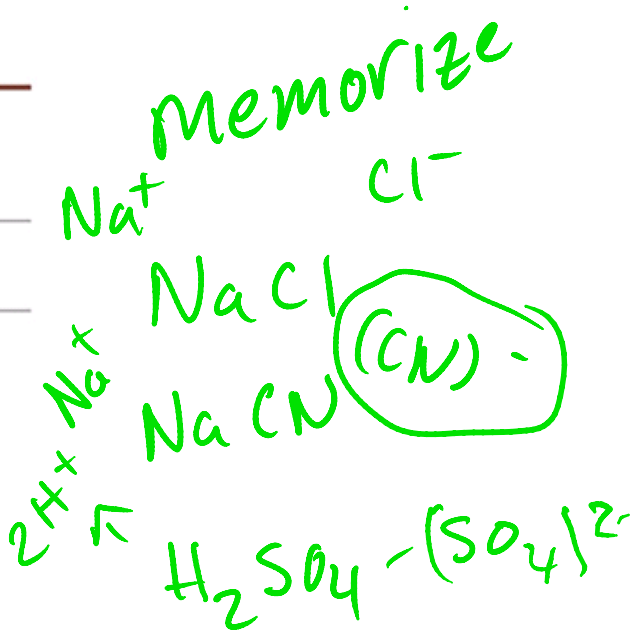


Table 2-4, p. 74

Extra Polyatomic Ions

Not on that table.

Formula	Name
N_3^-	Azide
SCN^-	Thiocyanate
O^{2-}	Oxide
O_2^{2-}	Peroxide
S^{2-}	Sulfide
N^{3-}	Nitride

Table 2-4, p. 74

Positive Ions

- Monatomic cations take the name of the element itself:

Na^+ - sodium ion Ca^{2+} - calcium ion Al^{3+} - aluminum ion

- For metals that can form different charges, the positive charge is given by a Roman numeral in parentheses following the name of the metal.

Fe^{2+} - iron(II) ion Cu^+ - copper(I) ion
Fe^{3+} - iron(III) ion Cu^{2+} - copper(II) ion

Positive Ions

• Older method use the *–ous* or *–ic*, representing the lower and higher charged ions, respectively .

Fe^{2+} - ferrous ion
Fe^{3+} - ferric ion

Cu^{+} - cuprous ion
Cu^{2+} - cupric ion

•Non-metals have names that end in *–ium.*

NH_4^+ - ammonium ion
H_3O^+ - hydronium ion

$NH_3 + H^+ \rightarrow NH_4^+$

Negative Ions

• Monatomic anions have names formed by dropping the ending of the name of the element and adding the ending *–ide.*

H^- - hydride ion O^{2-} - oxide ion N^{3-} - nitride ion

halogens

Cl^- – chloride

• Polyatomic anions containing oxygen have names ending in *–ate* or *-ite.*

NO_3^- - nitrate ion SO_4^{2-} - sulfate ion

NO_2^- - nitrite ion SO_3^{2-} - sulfite ion

Negative Ions

• Monatomic anions have names formed by dropping the ending of the name of the element and adding the ending *–ide.*

H^- - hydride ion O^{2-} - oxide ion N^{3-} - nitride ion

• Polyatomic anions containing oxygen have names ending in *–ate* or *-ite.*

NO_3^- - nitrate ion SO_4^{2-} - sulfate ion
NO_2^- - nitrite ion SO_3^{2-} - sulfite ion

Nomenclature

Names of ionic compounds are the cation name followed by the name of anion.

$Al(NO_3)_3$ → aluminum nitrate

CuI → copper(I) iodide

CuI_2 → copper(II) iodide

NaCl → sodium chloride

CaF_2 → calcium flouride

Molecular Compounds

Usually a non-metal + non-metal

- Leftmost (based on periodic table) element is usually written first.
- If in the same group, the lowest is named first.
- The name of the second element is give an *–ide* ending.
- Greek prefixes (mono, di, tri, tetra…) are used to indicate the number of each atom. Mono is never used on the first element.

N_2O_4 dinitrogen tetraoxide
NF_3 nitrogen trifluoride
P_4S_{10} tetraphosphorus decasulfide

CO carbon monoxide

Mole

A **mole** is defined as the amount of matter that contains as many objects (atom, molecules, etc) as the number of atoms in exactly 12 g of ^{12}C.

Avogadro's Number = 6.0221367 x 10^{23}

1 mol ^{12}C atoms	= 6.02 x 10^{23}	^{12}C atoms
1 mol H_2O molecules	= 6.02 x 10^{23}	H_2O molecules
1 mol Na^+ ions	= 6.02 x 10^{23}	Na^+ ions

Molar Mass

Molar Mass is the quantity in grams numerically equal to its atomic (or formula) weight.

One ^{12}C atom weighs 12 u; 1 mol ^{12}C weighs 12 g
One ^{24}Mg atom weighs 24 u; 1 mol ^{24}Mg weighs 24 g

M of ^{24}Mg is 24.0 g/mol
M of Mg is 24.3 g/mol

MASS ⟷ MOLES CONVERSION

Moles to Mass

$$\text{Moles} \times \frac{\text{grams}}{1\ \text{mol}} = \text{grams}$$

↑ molar mass

Mass to Moles

$$\text{Grams} \times \frac{1\ \text{mol}}{\text{grams}} = \text{moles}$$

↑ 1/molar mass

p. 83

Formula Weight

The **Formula Weight** of a substance is the sum of the atomic weights of each atom in its chemical formula.

H_2SO_4

FW = 2(AW of H) + (AW of S) + 4 (AW of O)
= 2(1.0 u) + (32.0 u) + 4 (16.0)
= 98.0 u

One H_2SO_4 molecule weighs 98.0 u; 1 mol H_2SO_4 weighs 98.0 g

M of H_2SO_4 is 98.0 g/mol