

LECTURE NOTES FOR GENERAL CHEMISTRY © 2007 MM
CHAPTER 2 ATOMS, MOLECULES, AND IONS © 2010 MM

LAWS OF CHEMICAL COMBINATION

MASS IS CONSERVED IN CHEMICAL REACTIONS

COMPOUNDS HAVE CONSTANT COMPOSITION

- BY MASS %

- BY NUMBER AND TYPE OF ATOMS

DALTONS ATOMIC THEORY OF MATTER :

- ALL MATTER IS COMPOSED OF INDIVISIBLE PARTICLES CALLED ATOMS
- ALL ATOMS OF A GIVEN ELEMENT ARE IDENTICAL
- ATOMS OF DIFFERENT ELEMENTS HAVE DIFFERENT PROPERTIES, ESPECIALLY DIFFERENT MASSES
- ATOMS ARE NEITHER CREATED, NOR DESTROYED IN CHEMICAL REACTIONS, ONLY REARRANGED
- COMPOUNDS ARE FORMED WHEN ATOMS OF DIFFERENT ELEMENTS COMBINE IN DEFINITE PROPORTIONS

THE DIVISIBLE ATOM

NEARLY THE ENTIRE MASS OF THE ATOM IS CONCENTRATED

IN THE NUCLEUS, MADE UP OF PROTONS MASS 1, CHARGE +1
AND

NEUTRONS MASS 1, CHARGE 0
THE 3rd PARTICLE, THE ELECTRON

HAS VERY SMALL MASS, BUT CHARGE = -1

ATOMIC NUMBER "Z" = # OF PROTONS p^+
ALSO
= # OF ELECTRONS e^-

ATOMIC MASS "A" = SUM OF PROTONS AND NEUTRONS

ISOTOPE S → SAME NUMBER OF PROTONS "Z"
→ DIFFERENT NUMBER OF NEUTRONS
AND THUS DIFFERENT MASS "A"

EXAMPLE:

FOR CARBON ${}^{12}_6\text{C}$ 6 p^+ AND 6 n^0

${}^{13}_6\text{C}$ 6 p^+ AND 7 n^0

${}^{14}_6\text{C}$ 6 p^+ AND 8 n^0

FOR URANIUM

${}^{235}_{92}\text{U}$ 92 p^+ AND 143 n^0

${}^{238}_{92}\text{U}$ 92 p^+ AND 146 n^0

THE PERIODIC TABLE - ELEMENTS ARRANGED BY ATOMIC #

- DIVIDED INTO ROWS (PERIODS) AND COLUMNS (GROUPS)
- METALS ON THE LEFT AND IN THE MIDDLE
- NONMETALS ON THE RIGHT
- AT THE BOUNDARY BETWEEN METALS AND NONMETALS

A MOLECULE IS A PARTICLE CONSISTING OF 2 OR MORE ATOMS HELD TOGETHER BY CHEMICAL BONDS

FOR EXAMPLE WATER H_2O 2 H ATOMS
1 O ATOM

OXYGEN O_2 2 O ATOMS

NITROGEN N_2 2 N ATOMS

CARBON DIOXIDE CO_2 1 C ATOM
2 O ATOMS

IONS

IONS ARE CHARGED PARTICLES

CATIONS ARE + CHARGED (MORE p^+ THAN e^-)

ANIONS ARE - CHARGED (MORE e^- THAN p^+)

CATIONS LIKE SODIUM Na^+ HAVE LOST AN ELECTRON

ANIONS LIKE CHLORIDE Cl^- HAVE GAINED AN ELECTRON

POLYATOMIC IONS

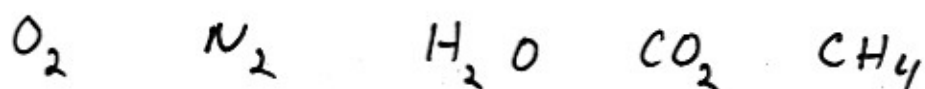
- CHARGED PARTICLES CONSISTING OF MORE THAN ONE ATOM

OH^- HYDROXIDE CO_3^{2-} CARBONATE

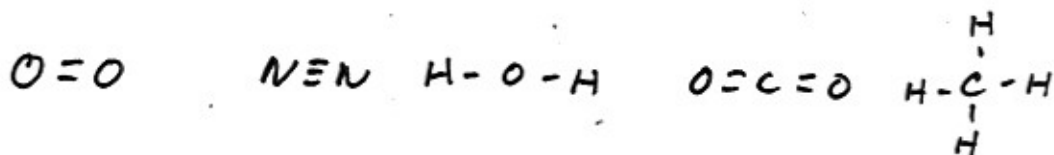
CHEMICAL FORMULAS

EXPRESS THE COMPOSITION OF MOLECULES AND IONIC COMPOUNDS USING CHEMICAL SYMBOLS

A MOLECULAR FORMULA SHOWS THE EXACT NUMBER OF ATOMS OF EACH ELEMENT

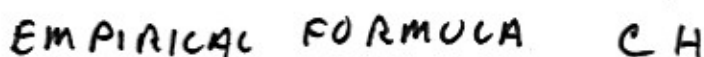
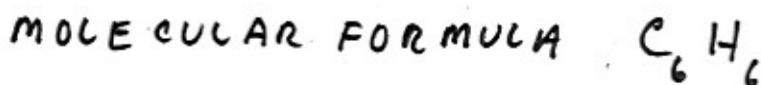


MOLECULAR MODELS ALLOW US TO VISUALIZE CHEMICAL BONDS



EMPIRICAL FORMULAS SHOW WHICH ELEMENTS ARE PRESENT IN THEIR SIMPLEST WHOLE-NUMBER RATIO

FOR EXAMPLE BENZENE (FROM GASOLINE)



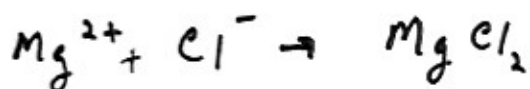
IONIC COMPOUNDS

- ARE REPRESENTED BY EMPIRICAL FORMULAS BECAUSE THEY EXIST IN LARGE, EXTENDED ARRAYS CALLED CRYSTALS
- IONIC COMPOUNDS ARE ELECTRICALLY NEUTRAL SO THE SUM OF + CHARGES EQUALS THE SUM OF -
- CATIONS ARE FORMED BY METALS, ESPECIALLY GROUP 1A AND 2A
 - 1A $\rightarrow Li^+, Na^+, K^+$ ETC
 - 2A $\rightarrow Mg^{2+}, Ca^{2+}, Sr^{2+}$ ETC
- ANIONS ARE FORMED BY NON METALS, SUCH AS GROUPS 6A AND 7A
 - 6A $\rightarrow O^{2-}, S^{2-}, Se^{2-}$
 - 7A $\rightarrow F^-, Cl^-, Br^-, I^-$

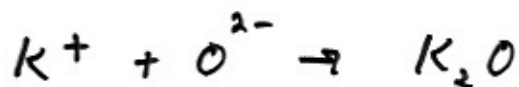
IONIC COMPOUNDS



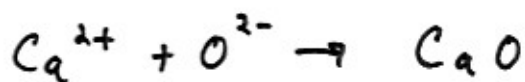
SODIUM CHLORIDE



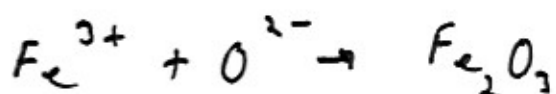
MAGNESIUM CHLORIDE



POTASSIUM OXIDE



CALCIUM OXIDE



IRON^(III) OXIDE

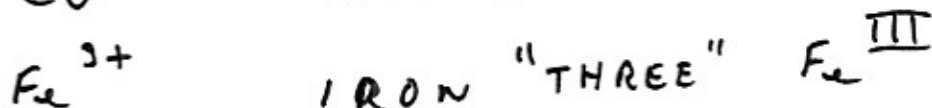
WHEN THE CHARGES ON THE 2 IONS ARE DIFFERENT
THE SUBSCRIPT OF THE CATION = VALUE OF ANION CHARGE
AND
THE SUBSCRIPT OF THE ANION = VALUE OF CATION CHARGE

NAMING IONIC COMPOUNDS

1) NAME THE METAL

2) NAME THE NONMETAL WITH "IDE"

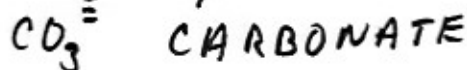
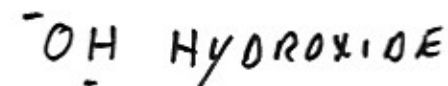
SOME METALS HAVE 2 (OR MORE) COMMON CHARGE STATES



NAMES OF COMMON ANIONS → TABLE 2.2

NAMES OF COMMON CATIONS AND ANIONS → TABLE 2.3

SOME IONS ARE "POLYATOMIC"

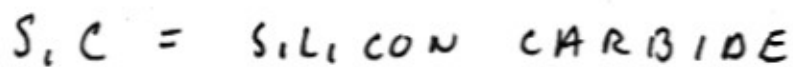


MOLECULAR COMPOUNDS

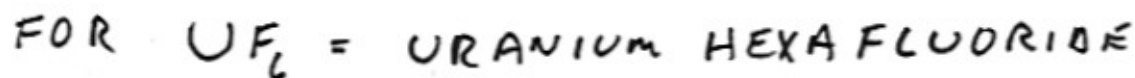
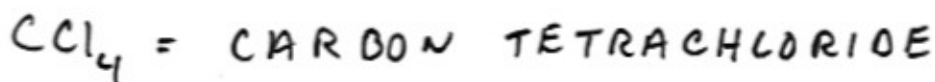
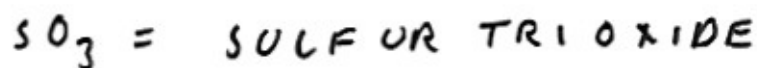
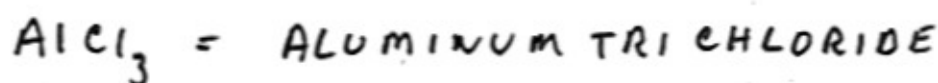
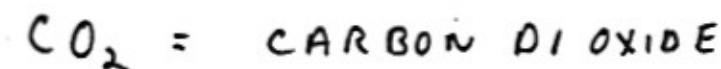
- EXIST AS DISCRETE MOLECULES
- MOSTLY FORMED BY NON METALS

NAMING

- BINARY COMPOUNDS NAMED THE SAME WAY AS IONIC COMPOUNDS
- NAME THE MOST METALLIC ELEMENT FIRST
MOST METALLIC MEANS RIGHTMOST ON THE PERIODIC TABLE OR LOWEST ON THE PERIODIC TABLE
- NAME THE LEAST METALLIC ELEMENT, ADD "IDE"



- TWO OR MORE OF THE SAME ATOM REQUIRES THE GREEK PREFIXES



COMPOUNDS CONTAINING HYDROGEN GET COMMON NAMES



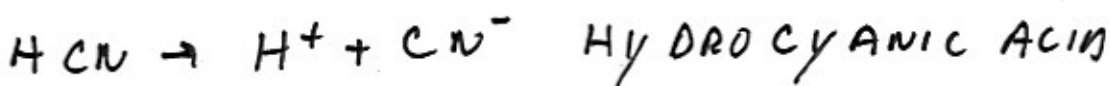
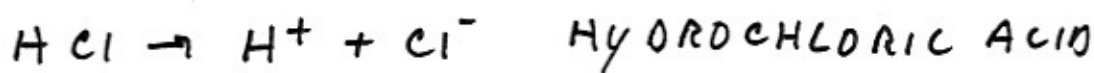
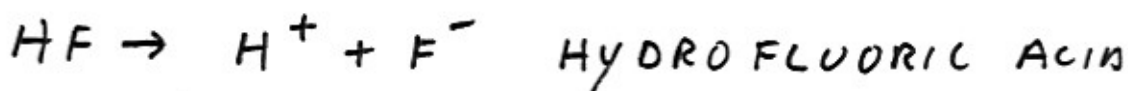
FIGURE 2.13 SUMMARIZES NAMING

ACIDS AND BASES

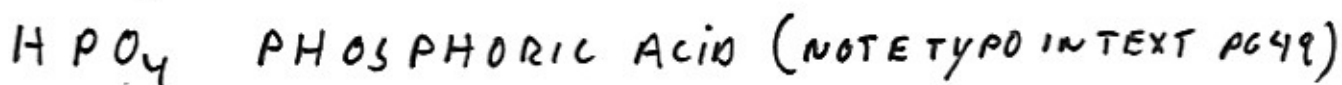
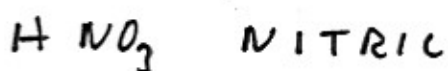
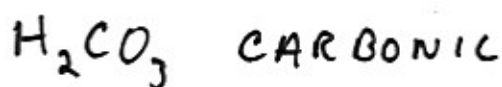
AN ACID IS A SUBSTANCE THAT PRODUCES HYDROGEN ION H^+ WHEN PLACED IN WATER

AN ANION IS ALSO PRODUCED

MOST ACIDS ARE NAMED WITH "IC" ENDING



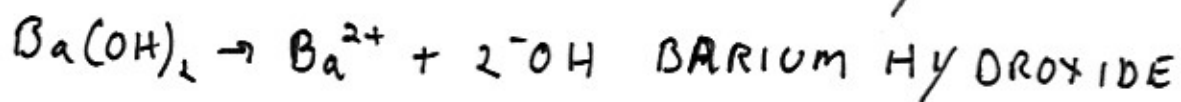
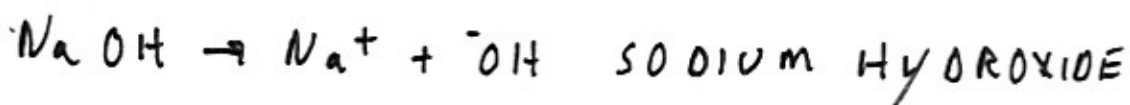
OXO ACIDS CONTAIN H, O AND ANOTHER ELEMENT



BASES

BASES ARE SUBSTANCES THAT PRODUCE HYDROXIDE ION

OH^- WHEN PLACED IN WATER



HYDRATES

- COMPOUNDS THAT HAVE A SPECIFIC NUMBER OF H_2O MOLECULES IN THEIR CRYSTAL STRUCTURE

