###### Chemical Particles Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

General Chemistry

 **Historical Development of the Atomic Model**

**Greeks (~400 B.C.E.)**

Greek model

of atom

-- Democritus, Leucippus, and others

 Matter is discontinuous (i.e., “grainy”).

 -- Plato and Aristotle disagreed, saying that matter was continuous.

**Hints at the Scientific Atom**

-- Antoine Lavoisier: law of conservation of mass

 -- Joseph Proust (1799)

law of definite proportions: every compound has a fixed proportion by mass

 e.g., water = 8 g O, 1 g H chromium (II) oxide = 13 g Cr, 4 g O

-- John Dalton (1803)

law of multiple proportions: When two different compounds have same two elements,

 equal mass of one element results in integer multiple of mass of other.

e.g., water = 8 g O, 1 g H; hydrogen peroxide = 16 g O, 1 g H

 e.g., chromium (II) oxide = 13 g Cr, 4 g O; chromium (VI) oxide = 13 g Cr, 12 g O

 **John Dalton’s Atomic Theory (1808)**

1. Elements are made of indivisible particles called atoms.

2. Atoms of the same element are exactly alike; in particular, they have the same mass.

3. Compounds are formed by the joining of atoms of two or more elements

Dalton’s model

of atom

 in fixed, whole number ratios, e.g.,

 *Dalton’s was the first atomic theory that had evidence to support it.*

Law of Electrostatic Attraction:

-- William Crookes (1870s): “Rays” causing a shadow were emitted from the cathode.

-- J.J. Thomson (1897) discovered that “cathode rays” are deflected by electric and magnetic

 fields. He found that “cathode rays” were particles (today, we call them electrons) having

 a charge-to-mass ratio of 1.76 x 108 C/g.

-- Robert Millikan (1909) performed the “oil drop” experiment. Oil drops were given negative

 charges of varying magnitude. Charges on oil drops were found to be integer multiples of

 1.60 x 10–19 C. He reasoned that this must be the charge on an electron. He then found

 the electron’s mass:

-- William Thomson (a.k.a., Lord Kelvin)

 Since atom was known to be electrically neutral, he proposed the plum pudding model.

+

–

+

+

+

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+

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+

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+

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 -- Equal quantities of (+) and (–) charge distributed uniformly in atom.

 -- (+) is ~2000X more massive than (–).

-- Ernest Rutherford (1910): Gold Leaf Experiment

 A beam of -particles (+) were directed at a gold leaf surrounded by a phosphorescent

 (ZnS) screen.

**.**

**.**

**.**

Most -particles passed through, some angled

slightly, and a tiny fraction bounced back.

 Conclusions:

 1.

 2.

 3.

-- James Chadwick discovered neutrons in 1932.

 Purpose of n0 =

electronic charge =

 -- In chemistry, charges are expressed as unitless multiples of this value, not in C.

 e.g.,

 -- atomic mass unit (amu): used to measure masses of atoms and subatomic particles

 1 p+ = 1.0073 amu; 1 n0 = 1.0087 amu; 1 e– = 0.0005486 amu

 Conversion:

Angstroms (A) are often used to measure atomic dimensions. Conversion:

atomic number:

-- the whole number on Periodic Table; determines the identity of an atom

mass number:

 isotopes: different varieties of an element’s atoms

######  --

 -- some are radioactive; others aren’t

 -- An atom of a specific isotope is sometimes called a nuclide.

 *All atoms of an element react the same, chemically.*

**The Periodic Table**

 group: a vertical column; elements in a group share certain phys. and chem. properties

-- group 1 = alkali metals

-- group 2 = alkaline earth metals

metals

nonmetals

metalloids

-- group 16 = chalcogens

-- group 17 = halogens

-- group 18 = noble gases

 Most molecular compounds contain only nonmetals.

 molecular formula:

 empirical formula:

 structural formula:

 Also... perspective drawing ball-and-stick model space-filling model

**Nomenclature of Binary Molecular Compounds**

 Use Greek prefixes to indicate how many atoms of each element, but don’t use “mono”

 on first element.

 1 – mono 3 – tri 5 – penta 7 – hepta 9 – nona

 2 – di 4 – tetra 6 – hexa 8 – octa 10 – deca

EXAMPLES:

carbon dioxide N2O5

CO carbon tetrachloride

dinitrogen trioxide NI3

**Ions and Ionic Compounds**

ion: a charged particle (i.e., a charged atom or group of atoms)

 anion: a (–) ion cation: a (+) ion

 -- more e– than p+ -- more p+ than e–

 -- formed when atoms lose e– -- formed when atoms gain e–

 polyatomic ion: a charged group of atoms

 Ionic compounds are also called salts, and they consist of oppositely-charged species

 attracted to each other by electrostatic forces. You can simplify ionic compounds as

 “metal-nonmetal,” but “cation-anion” is a little better.

**Nomenclature of Ionic Compounds**

chemical formula: has neutral charge; shows types of atoms and how many of each

To write an ionic compound’s formula, we need: 1. the two types of ions

 2. the charge on each ion

 Na+ and F–

 Ba2+ and O2–

 Na+ and O2–

 Ba2+ and F–

Parentheses are required only when you need more than one “bunch” of a particular polyatomic ion.

 Ba2+ and SO42–

 Mg2+ and NO2–

 NH4+ and ClO3–

 Sn4+ and SO42–

 Fe3+ and Cr2O72–

 NH4+ and N3–

Single-Charge Cations with Elemental Anions

 For this class, the single-charge cations are groups 1, 2, 13, and...

 Ag+, Zn2+, Cd2+, Sc3+, Y3+, Zr4+, Hf4+, Ta5+.

A. To name, given the formula: 1. Use name of cation.

 2. Use name of anion (it has the ending “ide”).

 NaF

 BaO

 Na2O

 BaF2

B. To write formula, given the name: 1. Write symbols for the two types of ions.

 2. Balance charges to write formula.

 silver sulfide

 zinc phosphide

 calcium iodide

Multiple-Charge Cations with Elemental Anions

 For this class, the multiple-charge cations are Pb2+/Pb4+, Sn2+/Sn4+, and

 all transition elements not listed above.

A. To name, given the formula: 1. Figure out charge on cation.

 2. Write name of cation.

Stock System

of nomenclature

 3. Write Roman numerals in ( ) to show cation’s charge.

 4. Write name of anion.

 FeO

 Fe2O3

CuBr

 CuBr2

B. To find the formula, given the name: 1. Write symbols for the two types of ions.

 2. Balance charges to write formula.

 cobalt (III) chloride

 tin (IV) oxide

 tin (II) oxide

Traditional System of Nomenclature

 …used historically (and still some today) to name compounds w/multiple-charge cations

To use: 1. Use Latin root of cation.

 2. Use ***-ic*** ending for higher charge; use ***-ous*** ending for lower charge. 3. Then say name of anion, as usual.

Element Latin root ***-ic -ous*** Write formulas. Write names.

gold, Au aur- Au3+ Au+ cuprous sulfide Pb3P4

lead, Pb plumb- Pb4+ Pb2+

tin, Sn stann- Sn4+ Sn2+ auric nitride Pb3P2

copper, Cu cupr- Cu2+ Cu+

iron, Fe ferr- Fe3+ Fe2+ ferrous fluoride SnCl4

Compounds Containing Polyatomic Ions

 Insert name of ion where it should go in the compound’s name.

 But first... oxyanions: polyatomic ions containing oxygen

 Common oxyanions:

 BrO31– NO31– CO32–

 IO31–  PO43–

 ClO31– SO42–

Above examples show “most common” forms of the oxyanions. If an oxyanion differs from the above by the # of O atoms, the name changes are as follows:

 one more O = per\_\_\_\_\_ate

 **“most common” # of O = \_\_\_\_\_ate**

 one less O = \_\_\_\_\_ite

 two fewer O = hypo\_\_\_\_\_ite

Write formulas: Write names:

 iron (III) nitrite (NH4)2S2O3

 ammonium phosphide AgBrO3

 ammonium chlorite (NH4)3N

 zinc phosphate U(CrO4)3

 lead (II) permanganate Cr2(SO3)3

**Acid Nomenclature**

 binary acids: acids w/H and one other element

 **Binary Acid Nomenclature**

 1. Write “hydro.”

 2. Write prefix of the other element, followed by “-ic acid.”

 HF

 HCl

 HBr

 hydroiodic acid

 hydrosulfuric acid

 oxyacids: acids containing H, O, and one other element

 **Oxyacid Nomenclature**

 For “most common” forms of the oxyanions, write prefix of oxyanion, followed by

 “-ic acid.”

 HBrO3

 HClO3

 H2CO3

 sulfuric acid

 phosphoric acid

 If an oxyacid differs from the above by the # of O atoms, the name changes are:

 one more O = per\_\_\_\_\_ic acid

 **“most common” # of O = \_\_\_\_\_ic acid**

 one less O = \_\_\_\_\_ous acid

 two fewer O = hypo\_\_\_\_\_ous acid

 HClO4

 HClO3

 HClO2

 HClO

 phosphorous acid

 hypobromous acid

 persulfuric acid