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

*AP Chemistry Lecture Outline*

**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…………………. chromium(II) oxide……..

-- 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…………………. chromium(II) oxide……..

hydrogen peroxide…. chromium(VI) oxide…….

**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…*

Law of Electrostatic Attraction:

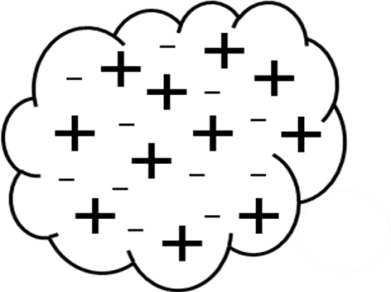
-- William Crookes (1870s): “Rays” causing a shadow were emitted from the cathode.

-- 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.

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



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

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

-- 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 a single electron. He then

found the electron’s mass:

-- Ernest Rutherford (1910): Gold Leaf Experiment

A beam of -particles (+) was 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

-- A nucleus of a specific isotope is sometimes called a…

***Complete Atomic Designation***

I

–

53

125

…gives precise info about an atomic particle

**mass # charge (if any)**

**element**

**symbol**

**atomic #**

|  |  |  |  |
| --- | --- | --- | --- |
| **Protons** | **Neutrons** | **Electrons** | Complete  **Atomic**  **Designation** |
| **92** | **146** | **92** |  |
| **11** | **12** | **10** |  |
| **34** | **45** | **36** |  |
|  |  |  | **59 3+**  **Co**  **27** |
|  |  |  | **37 –**  **Cl**  **17** |
|  |  |  | **55 7+**  **Mn** |

***Average Atomic Mass (a.k.a., Atomic Mass or Atomic Weight)***

This is the weighted average mass of all atoms of an element, measured in a.m.u.

For an element with isotopes A, B, etc.:

EX. Lithium has two isotopes. Li-6 atoms have mass 6.015 amu; Li-7 atoms have mass

7.016 amu. Li-6 makes up 7.5% of all Li atoms. Find AAM of Li.

\*\* Decimal number on Table refers to…

|  |  |  |
| --- | --- | --- |
| **Isotope** | **Mass** | **% abundance** |
| Si-28 | 27.98 amu | 92.23% |
| Si-29 | 28.98 amu | 4.67% |
| Si-30 |  |  |

EX. Complete the table.

**The Periodic Table**

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

-- group 1 =

-- group 2 =

metals

nonmetals

metalloids

-- group 16 =

-- group 17 =

-- group 18 =

Molecular compounds contain only…

empirical formula: shows relative #s of each type of atom in m’cule

molecular formula: shows actual #s & types of atoms in m’cule

structural formula: shows which atoms are bonded to which

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 – 3 – 5 – 7 – 9 –

2 – 4 – 6 – 8 – 10 –

EX: 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… -- formed when…

polyatomic ion: a charged group of atoms

Memorize:

NH4+ ammonium NO3– nitrate CO32– carbonate

CH3COO– acetate ClO3– chlorate HCO3– bicarbonate

PO43– phosphate BrO3– bromate SO42– sulfate

MnO4– permanganate IO3–  iodate HSO4– bisulfate

CrO42– chromate CN– cyanide

Cr2O72– dichromate OH– hydroxide

Ionic compounds, or salts, consist of oppositely-charged species bonded by electrostatic

forces. You can describe salts as “metal-nonmetal,” but “cation-anion” is 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– Na+ and O2–

Ba2+ and O2– Ba2+ and F–

Parentheses are req’d only with multiple “bunches” of a particular polyatomic ion.

Ba2+ and SO42– Sn4+ and SO42–

Mg2+ and NO2– Fe3+ and Cr2O72–

NH4+ and ClO3– NH4+ and N3–

Fixed-Charge Cations with Elemental Anions

For this class, the fixed-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 Na2O

BaO 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

Variable-Charge Cations with Elemental Anions

For this class, the variable-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 CuBr

Fe2O3 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

Compounds Containing Polyatomic Ions

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

But first... oxyanions: polyatomic ions containing oxygen

“Most common” oxyanions:

BrO3– ClO3– PO43– CO32–

IO3–  NO3– SO42–

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 fewer O = \_\_\_\_\_ite

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

*Write formulas: Write names:*

iron(III) nitrite (NH4)2SO4

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 fewer O = \_\_\_\_\_ous acid

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

HClO4

HClO3

HClO2

HClO

phosphorous acid

hypobromous acid

persulfuric acid