

Chapter 2 problems:

43, 45-48, 51, 57 – 59, 61-74, 82

Chapter 2 - Atoms, Molecules and Ions

Early History of Chemistry

400 B.C. Greeks thought that all matter is composed of 1 of 4 elements

Earth Water Air Fire

Also argued whether matter could be divided into infinitely smaller pieces or composed of small, indivisible particles, which they termed *Atomos* (later became atom)

Read p. 40-52 on your own, particularly the discussion on J.J. Thompson and Ernest Rutherford.

Modern Atomic Structure

TABLE 2.1 The Mass and Charge of the Electron, Proton, and Neutron

Particle	Mass	Charge*
Electron	9.11×10^{-31} kg	1-
Proton	1.67×10^{-27} kg	1+
Neutron	1.67×10^{-27} kg	None

*The magnitude of the charge of the electron and the proton is 1.60×10^{-19} C.

Diameter of the: Nucleus
 10^{-13} cm

Electron Cloud
 10^{-8} cm

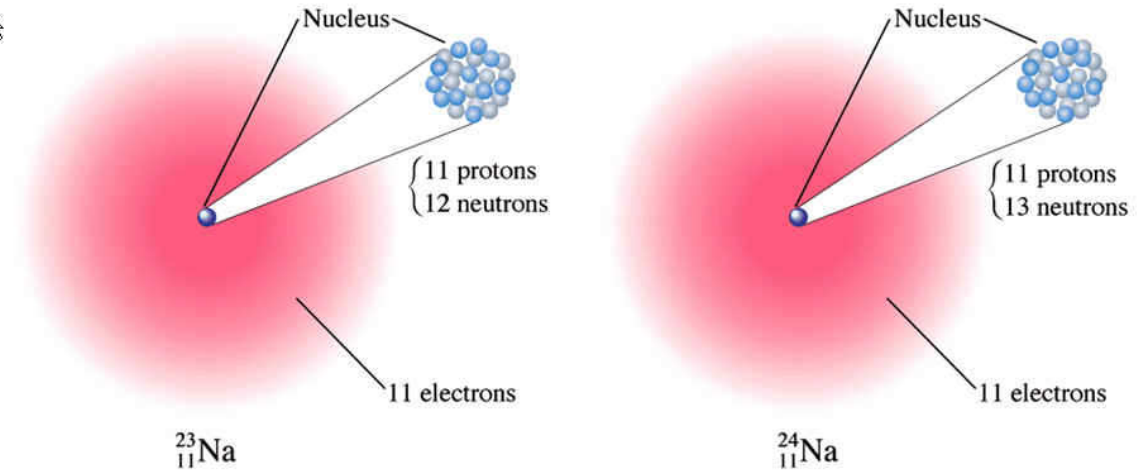
Names of elements are derived from Latin (the following are all Latin) Greek and German names.

TABLE 2.2 The Symbols for the Elements That Are Based on the Original Names

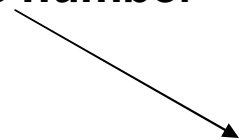
Current Name	Original Name	Symbol
Antimony	Stibium	Sb
Copper	Cuprum	Cu
Iron	Ferrum	Fe
Lead	Plumbum	Pb
Mercury	Hydrargyrum	Hg
Potassium	Kalium	K
Silver	Argentum	Ag
Sodium	Natrium	Na
Tin	Stannum	Sn
Tungsten	Wolfram	W

The number of protons defines the type of element

Isotopes – 2 atoms with the same number of protons (same element) but different number of neutrons.



(A) Mass number

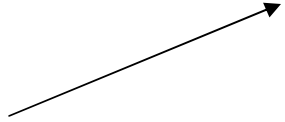


$^{23}_{11}\text{Na}$

How many protons? Neutrons?

The other way to write this isotope is Na-23

(z) Atomic number



Na-22

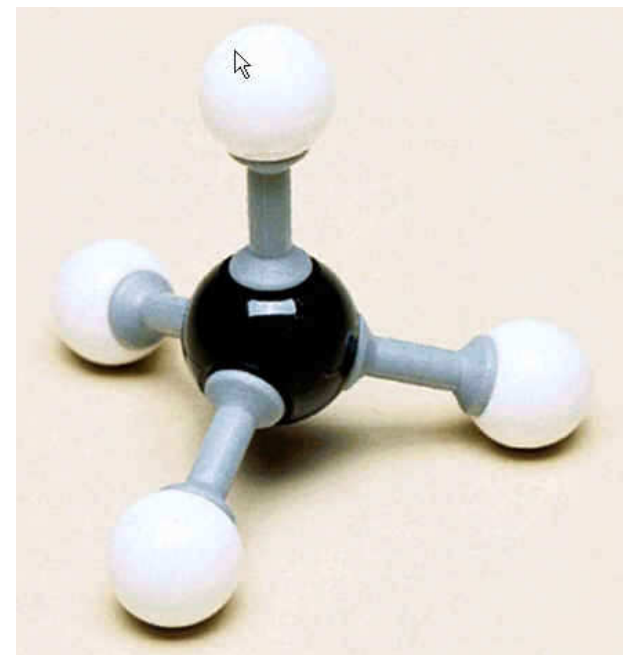
protons? Neutrons?

Molecules and Ions:

Forces that hold atoms together - Bond

Types of Bonds

1. **Covalent Bond** - Atoms share electrons with each other
Typically involve non – metals attaching to non – metals
Result is a molecule – (molecule boundary is where covalent bonding ends).



Problem: Draw the Lewis Structure of H_2O and CH_4

2. **Ionic Bond** – Formed between particles whose charges are opposite each other ... occurs between metals and non-metals

Metals tend to lose electrons, becoming a positive ion or cation.

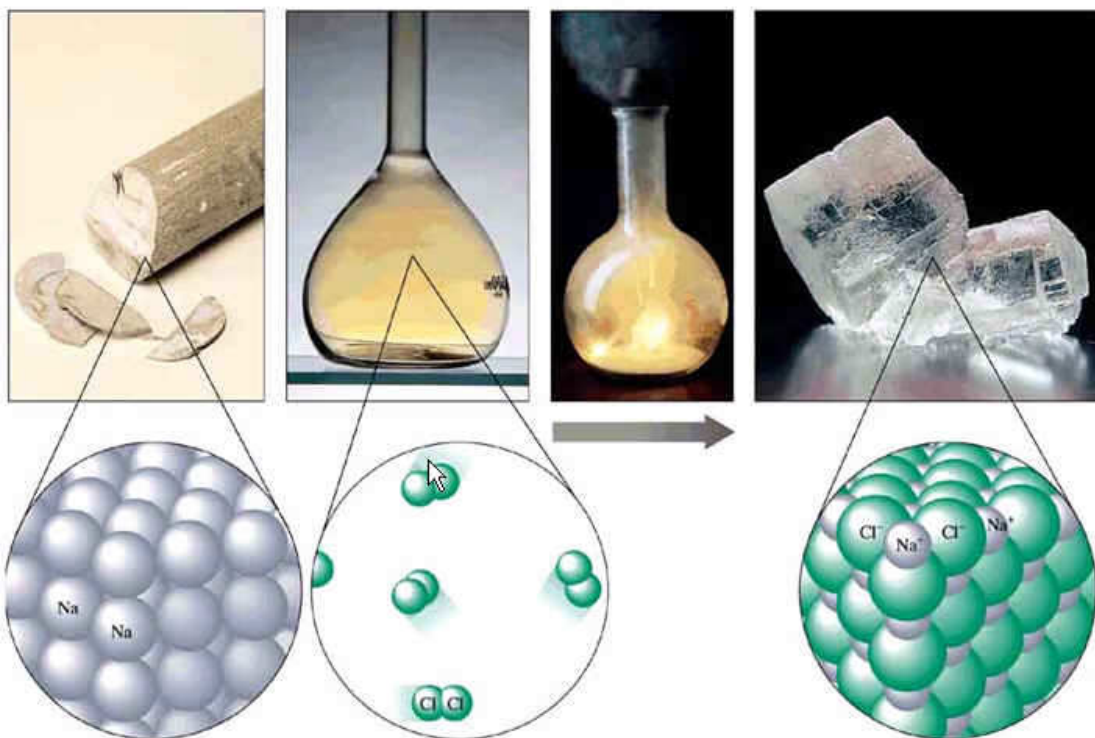
Non – metals tend to gain electrons, becoming a negative ion or anion.



Makes Na^+Cl^- or sodium chloride

Sodium chloride is not a molecule. Why?

Actually called an ionic solid or salt



Polyatomic ion: usually several non-metals with a charge

e.g. NH_4^+ or PO_4^{-3}

What type of bonding exists between

N and H?

P and O?

NH_4^+ and PO_4^{-3}

Periodic Table – Many properties of elements are predicted based on position of the element in the periodic table.

Metals: **Conductor of heat and electricity**
Malleable – hammer into a thin sheet
Ductile – pull into a wire
Tend to lose electrons, and become a cation

Non – metals: (exc. H) toward the right side of the periodic table
tend to gain electrons and become anions
form salts with metals
form discrete molecules with other non-metals

1 H	2 He											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg	Transition metals										13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	57 La*	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
87 Fr	88 Ra	89 Ac†	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Uun	111 Uuu	112 Uub						

*Lanthanides	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
†Actinides	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

Group or Family – (column)

- group 1 - (exc. H) Alkali Metals
- group 2 – Alkaline Earth Metals
- group 17 – Halogens
- group 18 – Noble gases

Periods – Horizontal Rows (there are 7 periods in the periodic table)

Alkali earth metals																	Noble gases		
1A	2A											3A	4A	5A	6A	7A	8A		
1 H	2 He											13 B	14 C	15 N	16 O	17 F	18 Ne		
3 Li	4 Be	3	4	5	6	7	8	9	10	11	12	13 Al	14 Si	15 P	16 S	17 Cl	18 Ar		
Alkali metals		Transition metals																	
11 Na	12 Mg	19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe		
55 Cs	56 Ba	57 La*	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn		
87 Fr	88 Ra	89 Ac†	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Uun	111 Uuu	112 Uub								

*Lanthanides

58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
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†Actinides

90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr
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Chemical Nomenclature (Naming Compounds)

Old Names: Quicklime, Epsom Salt, Milk of Magnesia, Gypsum, Laughing Gas

These names say nothing about what the substance contains. To date, There are over 5 million known compounds. Memorization is impossible.

Therefore, compounds are named based on the elements that make them up.

Inorganic Binary Comounds

Type I metal – only 1 charge exists for the metal

Type II metal – 2 or more charges exist for the metal

Problem: Identify the following metals as Type I or Type II, using your periodic table:

Na

Ca

Fe

Cu

Ag

N

Type I Metal / Non-metal – Name the cation, then the anion, changing the anion ending to ide

F⁻ = fluoride

O⁻² = oxide

P⁻³ = phosphide

Name the following:

Li₃N

Mg₂P₃

KI

Type II metals are named as their element name, then a roman numeral, indicating the charge of the metal.

Fe⁺² vs. Fe⁺³

Type II metal / non-metal – must show the charge of the cation with a roman numeral name. The charge of all cations + anions = 0

Name the following:

CuCl

Fe₂O₃

MgO

Cu₂O

p. 66 has the polyatomic ion table. Memorize all names, formulas and charges

If a polyatomic ion exists in a compound, don't change the name of the polyatomic ion

Name the following:



Non-metal compounds:

1. Use full first name of first element
2. Second element : change suffix of element to end with ide
3. Use greek prefixes to indicate proportions of each element (exc. 1 of first element)

Name the following:

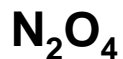
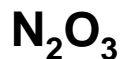
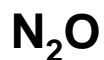
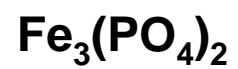
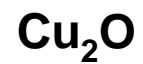
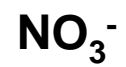
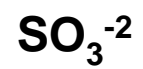
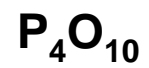


TABLE 2.6 Prefixes Used to Indicate Number in Chemical Names

Prefix	Number Indicated
<i>mono-</i>	1
<i>di-</i>	2
<i>tri-</i>	3
<i>tetra-</i>	4
<i>penta-</i>	5
<i>hexa-</i>	6
<i>hepta-</i>	7
<i>octa-</i>	8
<i>nona-</i>	9
<i>deca-</i>	10

Name the following:



Formulas are written on the basis that all charges add up to zero

Write formulas for the following:

Vanadium (V) chlorate

Rubidium peroxide (O_2^{-2})

Dioxygen difluoride

Gallium sulfate

Acid – substance that produces H⁺ ions in water

Without oxygen: hydro_____ic acid

Name the following:

HCl

HCN

**With oxygen: ite anion ous suffix
 ate anion ic suffix**

H₂S

Name the following:

HI

HNO₃ and HNO₂

HClO HClO₂ HClO₃ and HClO₄

H₂SO₄ and H₃PO₄ don't conform to the rule above.

HBrO₂, HIO

HIOAg

Note: HCl_(g) vs. HCl_(aq)

Write formulas for:

Acetic acid

Periodic acid

Carbonic acid