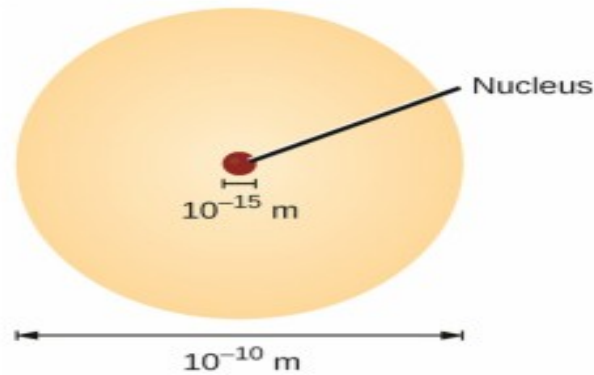


CHAPTER 4

4.1. Atomic structure and symbolism

- An atom contains a very small nucleus composed of positively charged protons and uncharged neutrons, surrounded by a much larger volume of space containing negatively charged electrons.
- The nucleus contains the majority of an atom's mass because protons and neutrons are much heavier than electrons, whereas electrons occupy almost all of an atom's volume.
- The diameter of an atom is on the order of 10^{-10} m, whereas the diameter of the nucleus is roughly 10^{-15}



- Atoms and the protons, neutrons, and electrons that compose them are extremely small. For example, a carbon atom weighs less than $2 \times 10^{-23} \text{ g}$, and an electron has a charge of less than $2 \times 10^{-19} \text{ C}$ (coulomb).
- the properties of tiny objects such as atoms, we use appropriately small units of measure, such as the **atomic mass unit (amu)** and the **fundamental**

- The amu has been defined with regard to the most abundant isotope of carbon, atoms of which are assigned masses of exactly 12 amu
- one amu is exactly 1/12 of the mass of one carbon-12 atom: $1 \text{ amu} = 1.6605 \times 10^{-24} \text{ g}$.
- (The **Dalton (Da)** and the **unified atomic mass unit (u)** are alternative units that are equivalent to the amu.)
- The fundamental unit of charge (also called the elementary charge) equals the magnitude of the charge of an electron (e) with $e = 1.602 \times 10^{-19} \text{ C}$.

- A proton has a mass of 1.0073 amu and a charge of 1^+ .
- A neutron is a slightly heavier particle with a mass 1.0087 amu and a charge of zero; as its name suggests, it is neutral.
- The electron has a charge of 1^- and is a much lighter particle with a mass of about 0.00055 amu
- Atoms are electrically neutral if they contain the same number of positively charged protons and negatively charged electrons.
- When the numbers of these subatomic particles are

Properties of Subatomic Particles

Name	Location	Charge (C)	Unit Charge	Mass (amu)	Mass (g)
Electron	outside nucleus	-1.602×10^{-19}	1-	0.00055	0.00091×10^{-24}
Proton	Nucleus	1.602×10^{-19}	1+	1.00727	1.67262×10^{-24}
Neutron	Nucleus	0	0	1.00866	1.67493×10^{-24}

atomic number(Z) = number of protons

mass number(A) = number of protons + number of neutrons

A – Z = number of neutrons

Atomic charge = number of protons – number of electrons

- An atom that gains one or more electrons will exhibit a negative charge and is called an **anion**.
- Positively charged atoms called **cations** are formed when an atom loses one or more electrons.
- For example, a neutral sodium atom ($Z = 11$) has 11 electrons.
- If this atom loses one electron, it will become a cation with a 1^+ charge ($11 - 10 = 1^+$).
- A neutral oxygen atom ($Z = 8$) has eight electrons, and if it gains two electrons it will become an anion with a 2^- charge ($8 - 10 = 2^-$).

➤ 4.1.1. Chemical Symbols and Isotopes

- A **chemical symbol** is an abbreviation that we use to indicate an element or an atom of an element.
- For example, the symbol for mercury is Hg
- Some symbols are derived from the common name of the element; others are abbreviations of the name in another language.
- Most symbols have one or two letters, but three-letter symbols have been used to describe some elements that have atomic numbers greater than 112

Isotopes

- Atoms that have the same atomic number but different mass numbers.
- The symbol for a specific isotope of any element is written by placing the mass number as a superscript to the left of the element symbol
- magnesium exists as a mixture of three isotopes, each with an atomic number of 12 and with mass numbers of 24, 25, and 26, respectively.
- These isotopes can be identified as ^{24}Mg , ^{25}Mg , and ^{26}Mg .

Mass number — 4 — 2+ — Charge

He

Atomic number — 2 —
(often omitted)

24 — 2+ — Charge

Mg

12

Nuclear Compositions of Atoms of the Very Light Elements

Element	Symbol	Atomic No.	No of Protons	No of Neutrons	Mass (amu)	% Natural Abundance
hydrogen	${}^1_1\text{H}(\text{protium})$	1	1	0	1.0078	99.989
	${}^2_1\text{H}(\text{deuterium})$	1	1	1	2.0141	0.0115
	${}^3_1\text{H}(\text{tritium})$	1	1	2	3.01605	— (trace)
Helium	${}^3_2\text{He}$	2	2	1	3.01603	0.00013
	${}^4_2\text{He}$	2	2	2	4.0026	100
Lithium	${}^6_3\text{Li}$	3	3	3	6.0151	7.59
	${}^7_3\text{Li}$	3	3	4	7.0160	92.41
Beryllium	${}^9_4\text{Be}$	4	4	5	9.0122	100
Boron	${}^{10}_5\text{B}$	5	5	5	10.0129	19.9
	${}^{11}_5\text{B}$	5	5	6	11.0093	80.1

➤ 4.1.2. Atomic mass unit and average atomic mass

The **atomic mass** of a single atom is approximately equal to its mass number (a whole number).

- However, the average masses of atoms of most elements are not whole numbers because most have two or more isotopes.
- $$\text{average mass} = \sum_i (\text{fractional abundance} \times \text{isotopic mass})_i$$

- For example, the element boron is composed of two isotopes: About 19.9% of all boron atoms are ^{10}B with a mass of 10.0129 amu, and the remaining 80.1% are

$$\begin{aligned}\text{boron average mass} &= (0.199 \times 10.0129 \text{ amu}) + (0.801 \times 11.0093 \text{ amu}) \\ &= 1.99 \text{ amu} + 8.82 \text{ amu} = 10.81 \text{ amu}\end{aligned}$$

10.8 amu is the average mass of all boron atoms, and individual boron atoms weigh either approximately 10 amu or 11 amu.

Example 4.2

Calculation of Average Atomic Mass

A meteorite found in central Indiana contains traces of the noble gas neon picked up from the solar wind during the meteorite's trip through the solar system.

Analysis of a sample of the gas showed that it consisted of 91.84% ^{20}Ne (mass 19.9924 amu), 0.47% ^{21}Ne (mass 20.9940 amu), and 7.69% ^{22}Ne (mass 21.9914 amu).

What is the average mass of the neon in the solar wind?

Solution

$$\begin{aligned} \text{average mas} &= (0.9184 \times 19.9924 \text{ amu}) + (0.0047 \times 20.9940 \text{ amu}) + (0.0769 \\ &\quad \times 21.9914 \text{ amu}) = (18.36 + 0.099 + 1.69) \text{ amu} = 20.15 \text{ amu} \end{aligned}$$

The average mass of a neon atom in the solar wind is 20.15 amu. (The average mass of a terrestrial neon atom is 20.1796 amu.)

This result demonstrates that we may find slight differences in the natural abundance of isotopes, depending on their origin.)

4.2. Chemical Formulas

A chemical formula gives the numbers and types of atoms that are found in a substance.

When the substance is a discrete molecule, then the chemical formula is also its molecular formula.

Fe (iron) is a chemical formula

Fe₂O₃ is a molecular formula

Molecular formulas.

The molecular formula of an element or compound only applies to elements or compounds that exist as molecules and it gives the actual number of each type of atom present in the molecule

The structural formula for a compound gives the same information as its molecular formula (the types and numbers of atoms in the molecule) but also shows how the atoms are connected in the molecule. (p)

atoms in the CH_4

(a) (b) (c) (d) of the

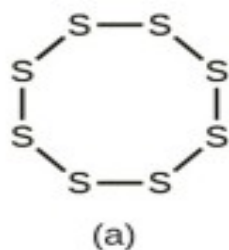
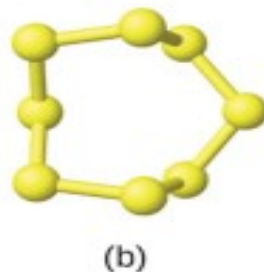
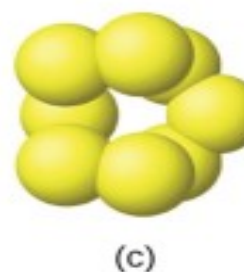
Figure 2.4: A methane molecule can be represented as (a) a molecular formula, (b) a structural formula, (c) a ball-and-stick model, and (d) a space-filling model. Carbon and hydrogen atoms are represented by black and white spheres, respectively

many elements consist of discrete, individual atoms, some exist as molecules made up of two or more atoms of the element chemically bonded together

diatomic molecules; composed of molecules that contain two atoms

For example: H_2 , O_2 , and N_2

Other elements composed of molecules that consist of eight atoms (



is S_8

Empirical Formula:

The empirical formula of a chemical compound represents the ratio of the elements present in that compound.

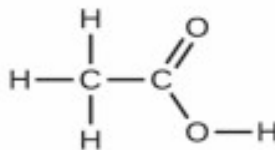
The chemical formula of the compound with the fewest possible number of atoms.

For example, the molecular formula for acetic acid, the component that gives vinegar its sharp taste, is $\text{C}_2\text{H}_4\text{O}_2$. This formula indicates that a molecule of acetic acid (Figure 2.9)

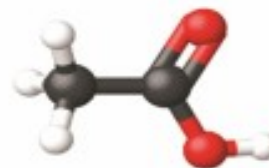
The ratio of atoms is 2:4:2. Dividing by the lowest common denominator (2) gives the simplest, whole-number ratio of atoms, 1:2:1, so the empirical formula is CH_2O



(a)



(b)



(c)

Figure 2.9: (a) Vinegar contains acetic acid, $\text{C}_2\text{H}_4\text{O}_2$, which has an empirical formula of CH_2O . It can be represented as (b) a structural formula and (c) as a ball-and-stick model.

4.3. The Periodic Table

4.3.1. Historical development of the periodic table

Antoine Lavoisier

In the late 1790s, he compiled a list of the known elements at the time.

This list contained 23 elements

In the 1800's, there were many changes in the world

- Electricity
- Spectrometer
- Industrial Revolution

As a result, there was an increase in the number of known elements

- By the 1870, there were 70 known elements

Then in the 1860's, chemist agreed upon a method for accurately determining the atomic mass of elements.

John Newlands

- Noticed when elements were arranged by atomic mass, they repeated properties every 8th element.
- He used the word periodic to describe this pattern
- He gave it the name the Law of Octaves

Unfortunately

- Did not work for all the elements
- Criticized because of its association with music
- Did give others the idea of repeating properties - periodic

Lothar Meyer and Dmitri Mendeleev

Each made a connection between atomic mass and properties of elements

Mendeleev

- Mendeleev is given credit because he was published first
- In addition, Mendeleev predicted unknown elements
- However, not completely correct – new elements weren't in correct order
- What do you notice about elements 27 & 28 and 52 & 53?

Henry Moseley

- Solved this problem by arranging the elements by increasing atomic number.
- The periodic repetition of chemical and physical properties of elements when arranged by atomic number is now known as Periodic Law

Which leads to the Modern Periodic Table

- the properties of the elements are periodic functions of their atomic numbers.
- A modern periodic table arranges the elements in increasing order of their atomic numbers and groups atoms with similar properties in the same vertical column
- The elements are arranged in seven horizontal rows, called periods or series, and 18 vertical columns, called groups. Groups are labeled at the top of each column

Period	Group																18																		
	1																	2																	
1	1 H 1.008 hydrogen																	2 He 4.003 helium																	
2	3 Li 6.94 lithium	4 Be 9.012 beryllium															5 B 10.81 boron	6 C 12.01 carbon	7 N 14.01 nitrogen	8 O 16.00 oxygen	9 F 19.00 fluorine	10 Ne 20.18 neon													
3	11 Na 22.99 sodium	12 Mg 24.31 magnesium															13 Al 26.98 aluminum	14 Si 28.09 silicon	15 P 30.97 phosphorus	16 S 32.06 sulfur	17 Cl 35.45 chlorine	18 Ar 39.95 argon													
4	19 K 39.10 potassium	20 Ca 40.08 calcium	21 Sc 44.96 scandium	22 Ti 47.87 titanium	23 V 50.94 vanadium	24 Cr 52.00 chromium	25 Mn 54.94 manganese	26 Fe 55.85 iron	27 Co 58.93 cobalt	28 Ni 58.69 nickel	29 Cu 63.55 copper	30 Zn 65.38 zinc	31 Ga 69.72 gallium	32 Ge 72.63 germanium	33 As 74.92 arsenic	34 Se 78.97 selenium	35 Br 79.90 bromine	36 Kr 83.80 krypton																	
5	37 Rb 85.47 rubidium	38 Sr 87.62 strontium	39 Y 88.91 yttrium	40 Zr 91.22 zirconium	41 Nb 92.91 niobium	42 Mo 95.95 molybdenum	43 Tc [97] technetium	44 Ru 101.1 ruthenium	45 Rh 102.9 rhodium	46 Pd 106.4 palladium	47 Ag 107.9 silver	48 Cd 112.4 cadmium	49 In 114.8 indium	50 Sn 118.7 tin	51 Sb 121.8 antimony	52 Te 127.6 tellurium	53 I 126.9 iodine	54 Xe 131.3 xenon																	
6	55 Cs 132.9 cesium	56 Ba 137.3 barium	57-71 La-Lu ★	72 Hf 178.5 hafnium	73 Ta 180.9 tantalum	74 W 183.8 tungsten	75 Re 186.2 rhenium	76 Os 190.2 osmium	77 Ir 192.2 iridium	78 Pt 195.1 platinum	79 Au 197.0 gold	80 Hg 200.6 mercury	81 Tl 204.4 thallium	82 Pb 207.2 lead	83 Bi 209.0 bismuth	84 Po [209] polonium	85 At [210] astatine	86 Rn [222] radon																	
7	87 Fr [223] francium	88 Ra [226] radium	89-103 Ac-Lr ★★	104 Rf [267] rutherfordium	105 Db [270] dubnium	106 Sg [271] seaborgium	107 Bh [270] bohrium	108 Hs [277] hassium	109 Mt [276] meitnerium	110 Ds [281] darmstadtium	111 Rg [282] roentgenium	112 Cn [285] copernicium	113 Nh [285] nihonium	114 Fl [289] flerovium	115 Mc [288] moscovium	116 Lv [293] livermorium	117 Ts [294] tennessine	118 Og [294] oganesson																	
																					57 La 138.9 lanthanum	58 Ce 140.1 cerium	59 Pr 140.9 praseodymium	60 Nd 144.2 neodymium	61 Pm [145] promethium	62 Sm 150.4 samarium	63 Eu 152.0 europium	64 Gd 157.3 gadolinium	65 Tb 158.9 terbium	66 Dy 162.5 dysprosium	67 Ho 164.9 holmium	68 Er 167.3 erbium	69 Tm 168.9 thulium	70 Yb 173.1 ytterbium	71 Lu 175.0 lutetium
																					89 Ac [227] actinium	90 Th 232.0 thorium	91 Pa 231.0 protactinium	92 U 238.0 uranium	93 Np [237] neptunium	94 Pu [244] plutonium	95 Am [243] americium	96 Cm [247] curium	97 Bk [247] berkelium	98 Cf [251] californium	99 Es [252] einsteinium	100 Fm [257] fermium	101 Md [258] mendelevium	102 No [259] nobelium	103 Lr [262] lawrencium

Atomic number → 1

Symbol → **H**

Atomic mass → 1.008

Name → hydrogen

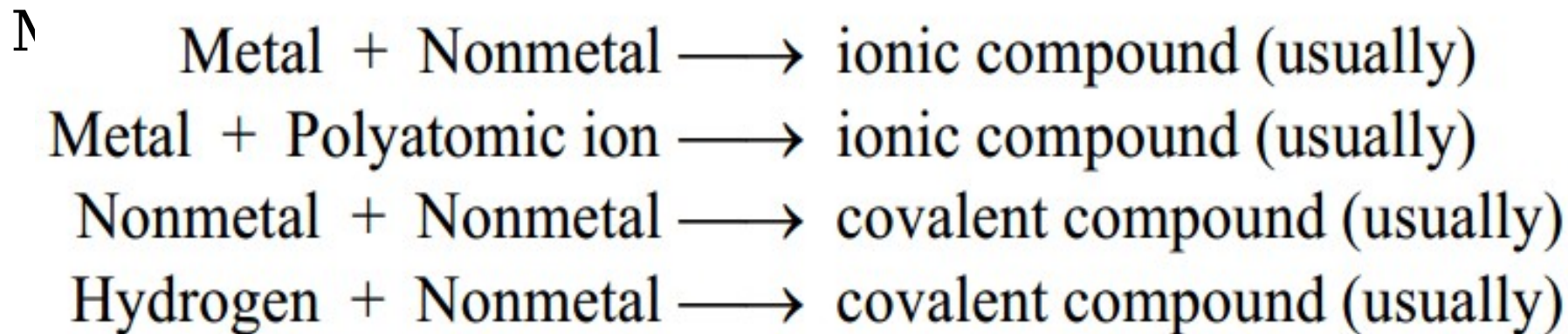
Color Code	
 Metal	Solid
 Metalloid	Liquid
 Nonmetal	Gas

4.3.2. Classification of elements in the periodic table

- The elements can also be classified into the main-group elements (or representative elements) in the columns labeled 1, 2, and 13–18;
- the transition metals in the columns labeled 3–12; and
- inner transition metals in the two rows at the bottom of the table (the top-row elements are called lanthanides and the bottom-row elements are actinide)

4.4. Ionic and Molecular Compounds

Ionic compounds are compounds composed of *ions*, charged particles that form when an atom (or group of atoms) gains or loses electrons. **Covalent** or **molecular compounds** form when elements share electrons in a covalent bond to form *molecules*.



➤ **Types of ions**

Main-Group Metals (Groups IA, IIA, and IIIA) Group IA, IIA, and IIIA metals tend to form *cations* by losing all of their outermost (valence) electrons.

➤ *The charge on the cation is the same as the group*

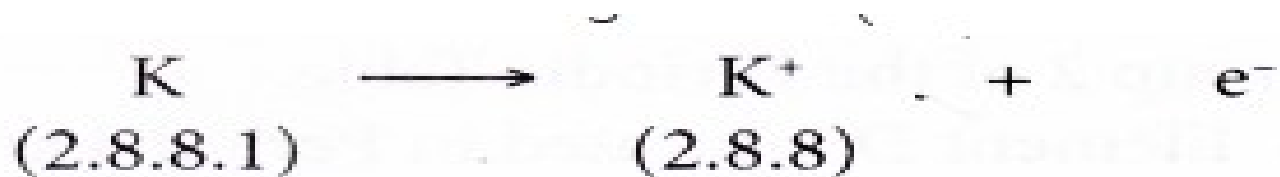
<u>Group</u>	<u>Element</u>	<u>Cation</u>	<u>Ion name</u>	<u>Group</u>	<u>Element</u>	<u>Cation</u>	<u>Ion name</u>
IA	H	H^+	hydrogen ion	IIA	Mg	Mg^{2+}	magnesium ion
	Li	Li^+	lithium ion		Ca	Ca^{2+}	calcium ion
	Na	Na^+	sodium ion		Sr	Sr^{2+}	strontium ion
	K	K^+	potassium ion		Ba	Ba^{2+}	barium ion
	Cs	Cs^+	cesium ion	IIIA	Al	Al^{3+}	aluminum ion

Ions of Some Transition Metals and Post-Transition Metals (Groups IVA and VA)

<u>Metal</u>	<u>Ion</u>	<u>Systematic name</u>	<u>Common name</u>
Cadmium	Cd^{2+}	cadmium ion	
Chromium	Cr^{2+}	chromium(II) ion	chromous ion
	Cr^{3+}	chromium(III) ion	chromic ion
Cobalt	Co^{2+}	cobalt(II) ion	cobaltous ion
	Co^{3+}	cobalt(III) ion	cobaltic ion
Copper	Cu^{+}	copper(I) ion	cuprous ion
	Cu^{2+}	copper(II) ion	cupric ion
Gold	Au^{3+}	gold(III) ion	
Iron	Fe^{2+}	iron(II) ion	ferrous ion
	Fe^{3+}	iron(III) ion	ferric ion

4.4.1. Formation of Ionic Compounds

- When an element composed of atoms that readily lose electrons (a metal) reacts with an element composed of atoms that readily gain electrons (a nonmetal), a transfer of electrons usually occurs, producing ions.
- The compound formed by this transfer is stabilized by the electrostatic attractions (ionic bonds) between the ions of opposite charge present in the compound
for example formation of potassium chloride, KCl
- each potassium atom loses one electron from its valence shell to achieve a **stable octet** electron arrangement (similar to the noble gas argon). A **positive ion, K^+** is formed.



- The electron lost by the potassium atom is transferred to a chlorine atom.
- A chlorine atom has a proton number of 17 and an electron arrangement of 2.8.7. A chlorine atom has seven valence electrons.
- Each chlorine atom gains one electron from a potassium atom into its valence shell to achieve a **stable octet** electron arrangement (similar to the noble gas argon). A **negative ion**, **Cl⁻** is formed.

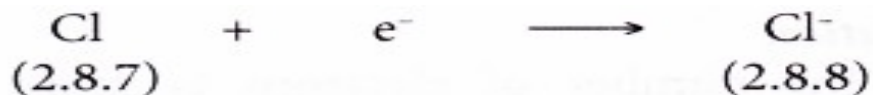
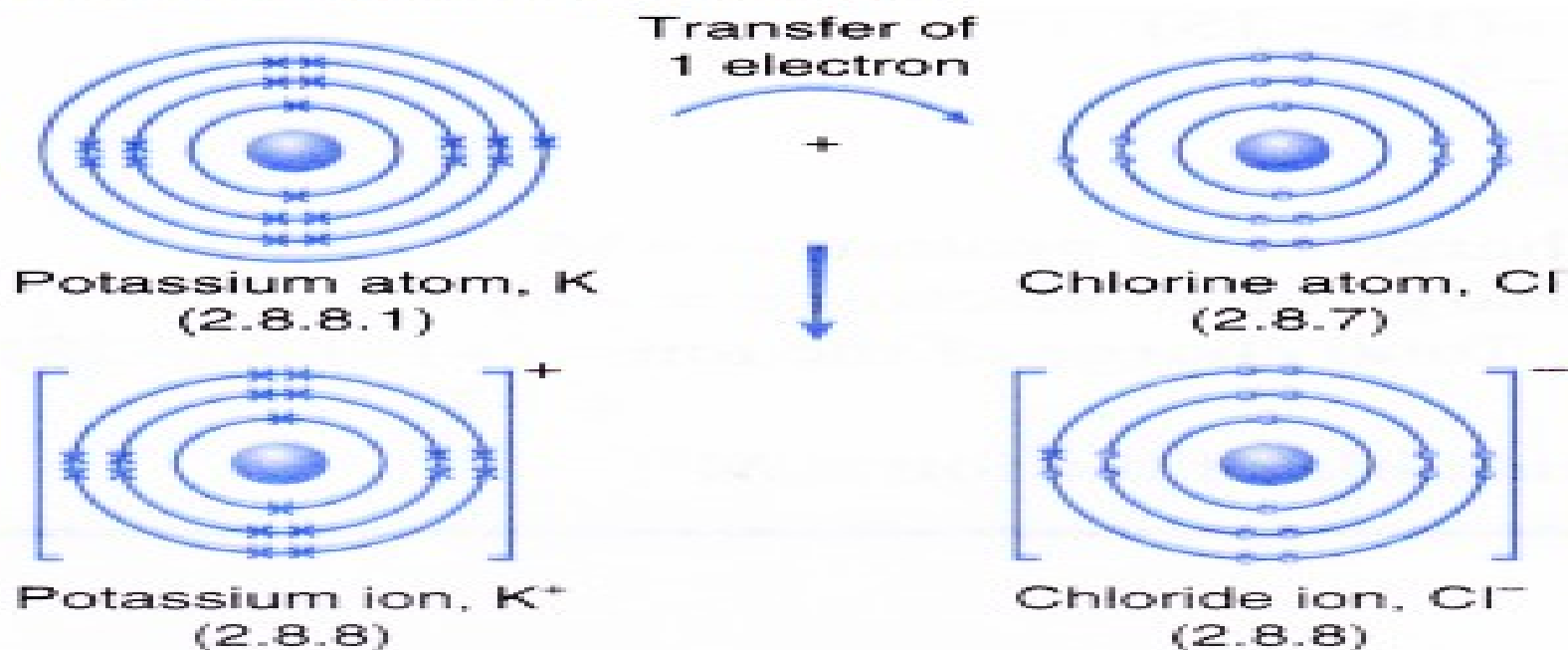


Diagram illustrating the formation of ionic compounds.

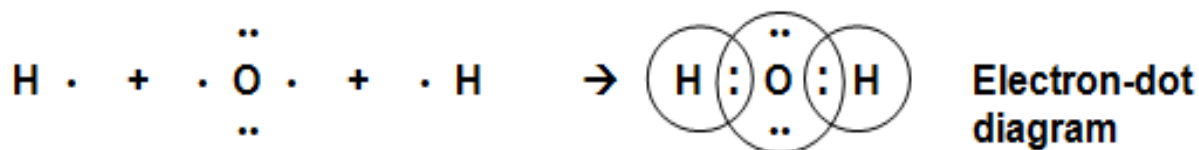
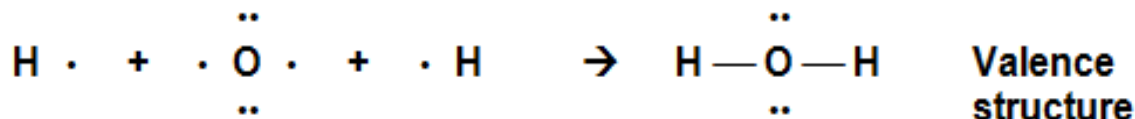


In every ionic compound, the total number of positive charges of the cations equals the total number of negative charges of the anions. Thus, ionic compounds are electrically neutral overall, even though they contain positive and negative ions.

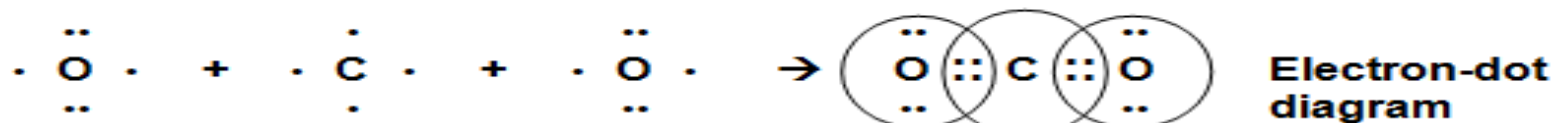
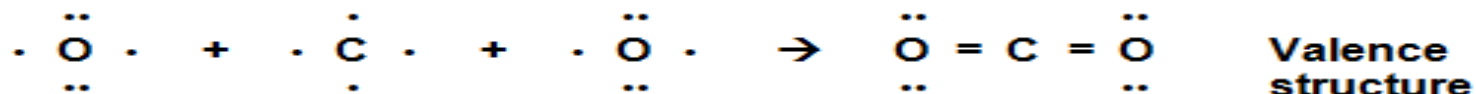
4.4.2. Formation of Molecular Compounds

when two or more atoms share valence (outer shell) electrons resulting in the formation of **molecular compounds**, which typically involve nonmetals.

formation of water



formation of carbon dioxide



4.5. Chemical Nomenclature

- Chemical nomenclature simply means the naming of chemical compounds
- Inorganic nomenclature is simplest for binary compounds, those compounds which contain two and only two chemical elements.
- The name of a compound is derived from the names of its elements and some general agreements among chemists

➤ 4.5.1. Ionic compounds

Ionic compounds containing fixed-charge metals
(mostly main group metals):

1. A monatomic cation has the same name as that of the parent element.

2. A monatomic anion is named by taking the root of the element name and adding -ide.

Example: NaCl	sodium
chloride	

Mg F ₂	magnesium
fluoride	

Table 4.5: Names of Some Ionic Compounds

NaCl, sodium chloride	Na ₂ O, sodium oxide
KBr, potassium bromide	CdS, cadmium sulfide
CaI ₂ , calcium iodide	Mg ₃ N ₂ , magnesium nitride
CsF, cesium fluoride	Ca ₃ P ₂ , calcium phosphide
LiCl, lithium chloride	Al ₄ C ₃ , aluminum carbide

- Ionic compounds containing variable charge cations (mostly transition metals):
- For metals that can form cations of more than one charge,
- the charge on the metal ion must be specified with

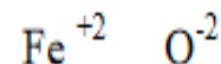
Ro1 - To calculate how many electrons Fe gave up.
 Write each element as many times as indicated by the subscript



- Put the correct charge on the non-metal



- Now balance the charges (you only have one Fe so the total negative charge will be on that one atom)

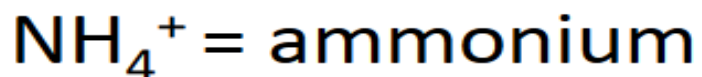
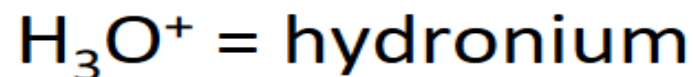


- now you are ready to name the compound

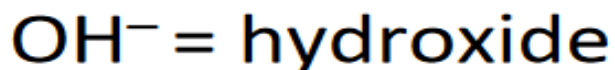
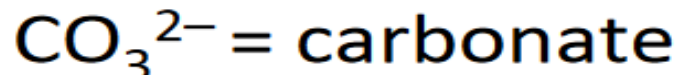
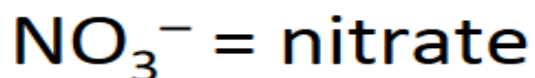
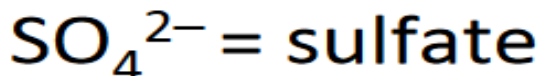
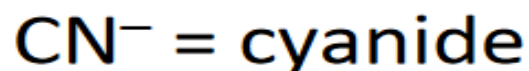
Iron (II) oxide

Names and charges of polyatomic ions.

Polyatomic cations: Names end in -ium.



Polyatomic anions: Many contain oxygen.



4.5.1.2. Compounds Containing Polyatomic Ions

Compounds containing polyatomic ions are named by naming first the cation and then the anion

Table 2.6: Names of Some Polyatomic Ionic

Co

$\text{KC}_2\text{H}_3\text{O}_2$, potassium acetate	NH_4Cl , ammonium chloride
NaHCO_3 , sodium bicarbonate	CaSO_4 , calcium sulfate
$\text{Al}_2(\text{CO}_3)_3$, aluminum carbonate	$\text{Mg}_3(\text{PO}_4)_2$, magnesium phosphate

4.5.1.3. Compounds Containing a Metal Ion with a Variable Charge

- The charge of the metal ion is included as a Roman numeral in parentheses immediately following the metal name
- transition metal + poly atomic ion

-Name the compound: CuSO_4 following

charge: *Example:* CuSO_4 Cu SO_4^{-2}

-Name the compound: CuSO_4 Balance: Change charge Cu^{+2} SO_4^{-2}

Now name the compound: Copper (II) sulfate

4.5.1.4. Ionic Hydrates

- Ionic compounds that contain water molecules as integral components of their crystals are called **hydrates**.
- The name for an ionic hydrate is derived by adding a term to the name for the anhydrous (meaning “not hydrated”) compound that indicates the number of water molecules associated with each formula unit of the compound
- Copper(II) sulfate pentahydrate $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$
Sodium carbonate decahydrate $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$

Nomenclature of Prefixes

Number	Prefix		Number	Prefix
1 (sometimes omitted)	mono-		6	hexa-
2	di-		7	hepta-
3	tri-		8	octa-
4	tetra-		9	nona-
5	penta-		10	deca-

Name the following ionic compounds

(a) Fe_2S_3 (b) CuSe (c) GaN (d) $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$ (e)

$\text{Ti}_2(\text{SO}_4)_3$

4.5.2. Molecular Compounds

- Molecular compounds are chemical compounds that take the form of discrete molecules
- examples include such familiar substances as water (H_2O) and carbon dioxide (CO_2)
- These compounds are very different from ionic compounds like sodium chloride (NaCl).
- Ionic compounds are formed when metal atoms lose one or more of their electrons to nonmetal atoms.
- The resulting cations and anions are electrostatically attracted to each other.

- So what holds the atoms of a molecule together?
- the atoms of a molecule share their valence electrons in such a way that a bond forms between pairs of atoms.
- In a carbon dioxide molecule, there are two of these bonds, each occurring between the carbon atom and one of the two oxygen atoms.

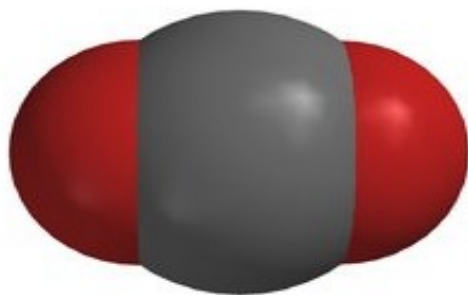


Figure 1. Carbon dioxide molecules consist of a central carbon atom bonded to two oxygen atoms.

4.5.2.1. Compounds Composed of Two Elements

- A binary molecular compound *is a molecular compound that is composed of two elements.*
- In general, the elements that combine to form binary molecular compounds are both nonmetals.
- When two nonmetallic elements form a molecular compound, several combination ratios are often possible
- For example, carbon and oxygen can form the compounds CO and CO₂.
- Since these are different substances with different properties they cannot both have the same name

Table. Names of Some Molecular Compounds Composed of Two Elements

Compound	Name		Compound	Name
SO ₂	sulfur dioxide		BCl ₃	boron trichloride
SO ₃	sulfur trioxide		SF ₆	sulfur hexafluoride
NO ₂	nitrogen dioxide		PF ₅	phosphorus pentafluoride
N ₂ O ₄	dinitrogen tetroxide		P ₄ O ₁₀	tetraphosphorus decaoxide
N ₂ O ₅	dinitrogen pentoxide		IF ₇	iodine heptafluoride

II. Binary Molecular Compounds

- Greek prefixes indicate number of atoms.

Examples

- dinitrogen pentoxide N_2O_5
- boron trifluoride BF_3

Greek Prefixes

mono	one
di	two
tri	three
tetra	four
penta	five
hexa	six

Examples of Binary Molecular Compounds

N_2O_5	dinitrogen pentoxide
P_4O_6	tetraphosphorus hexoxide
BF_3	boron trifluoride
NO	nitrogen monoxide
CO	carbon monoxide

Table 5.3 Prefixes Used to Indicate Numbers 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

4.5.2.2. Binary Acids

- Binary acid is a compound (comprised of hydrogen and one other nonmetallic element):
a mixture of water with an acid is given a name derived from the compound's name
1. The word “hydrogen” is changed to the prefix *hydro-*
 2. The other nonmetallic element name is modified by adding the suffix *-ic*
 3. The word “acid” is added as a second word.

Names of Some Simple Acids

Name of Gas	Name of Acid
HF(g), hydrogen fluoride	HF(aq), hydrofluoric acid
HCl(g), hydrogen chloride	HCl(aq), hydrochloric acid
HBr(g), hydrogen bromide	HBr(aq), hydrobromic acid
HI(g), hydrogen iodide	HI(aq), hydroiodic acid
H ₂ S(g), hydrogen sulfide	H ₂ S(aq), hydrosulfuric acid

4.5.2.3. Oxyacids

compounds that contain hydrogen, oxygen, and at least one other element, and are bonded in such a way as to impart acidic properties to the compound.

Typical oxyacids consist of hydrogen combined with a polyatomic, oxygen-containing ion. To name oxyacids:

1. Omit “hydrogen”
2. Start with the root name of the anion
3. Replace *-ate* with *-ic*, or *-ite* with *-ous*
4. Add “acid”

Names of Common Oxyacid

Formula	Anion Name	Acid Name
$\text{HC}_2\text{H}_3\text{O}_2$	Acetate	acetic acid
HNO_3	Nitrate	nitric acid
HNO_2	Nitrite	nitrous acid
HClO_4	Perchlorate	perchloric acid
H_2CO_3	Carbonate	carbonic acid
H_2SO_4	Sulfate	sulfuric acid
H_2SO_3	Sulfite	sulfurous acid
H_3PO_4	Phosphate	phosphoric acid