



*Chem*

*With*

*Com*

# Lewis Structures, Bonding, and Molecules

- Chapter 2.4 (Chemical Formulas)
- Chapter 4.4 (Lewis Symbols and Structures)
- Chapter 3.6 (The Periodic Table)
- Chapter 3.7 (Ionic and Molecular Compounds)
- Chapter 1.2 (Phases and Classifications of Matter)

# Lewis Symbols, Octet Rule, and Ionic Bonds

- Chapter 4.4 (Lewis Symbols and Structures)
- Chapter 3.6 (The Periodic Table)
- Chapter 3.7 (Ionic and Molecular Compounds)

# Lewis Symbols and Structures

## Lewis Symbols

We use Lewis symbols to describe valence electron configurations of atoms and monatomic ions. A **Lewis symbol** consists of an elemental symbol surrounded by one dot for each of its valence electrons:



[Figure 4.10](#) shows the Lewis symbols for the elements of the third period of the periodic table.

# Ions

<b>1</b> 1 <b>H</b> 1.008 hydrogen								<b>18</b> 2 <b>He</b> 4.003 helium
<b>2</b> 3 <b>Li</b> 6.94 lithium	<b>2</b> 4 <b>Be</b> 9.012 beryllium	<b>13</b> 5 <b>B</b> 10.81 boron	<b>14</b> 6 <b>C</b> 12.01 carbon	<b>15</b> 7 <b>N</b> 14.01 nitrogen	<b>16</b> 8 <b>O</b> 16.00 oxygen	<b>17</b> 9 <b>F</b> 19.00 fluorine	<b>10</b> 10 <b>Ne</b> 20.18 neon	
<b>3</b> 11 <b>Na</b> 22.99 sodium	<b>12</b> 12 <b>Mg</b> 24.31 magnesium					<b>17</b> 17 <b>Cl</b> 35.45 chlorine	<b>18</b> 18 <b>Ar</b> 39.95 argon	

- Rows (periods) = energy levels
- Columns (groups) = valence electrons
- Columns (groups) = predicted charge (usually)

# Lewis Symbols and Structures

<p>1</p> <p>1</p> <p><b>H</b> 1.008 hydrogen</p>								<p>18</p> <p>2</p> <p><b>He</b> 4.003 helium</p>
<p>2</p> <p>3</p> <p><b>Li</b> 6.94 lithium</p>	<p>2</p> <p>4</p> <p><b>Be</b> 9.012 beryllium</p>	<p>13</p> <p>5</p> <p><b>B</b> 10.81 boron</p>	<p>14</p> <p>6</p> <p><b>C</b> 12.01 carbon</p>	<p>15</p> <p>7</p> <p><b>N</b> 14.01 nitrogen</p>	<p>16</p> <p>8</p> <p><b>O</b> 16.00 oxygen</p>	<p>17</p> <p>9</p> <p><b>F</b> 19.00 fluorine</p>	<p>10</p> <p><b>Ne</b> 20.18 neon</p>	
<p>3</p> <p>11</p> <p><b>Na</b> 22.99 sodium</p>	<p>12</p> <p><b>Mg</b> 24.31 magnesium</p>					<p>17</p> <p><b>Cl</b> 35.45 chlorine</p>	<p>18</p> <p><b>Ar</b> 39.95 argon</p>	

- Rows (periods) = energy levels
- Columns (groups) = valence electrons
- Columns (groups) = predicted charge (usually)

Octet Rule (Chapter 4.4)  
Guideline that states that main group atoms will  
“want” 8 electrons

# Lewis Structures

Atoms	Lewis Symbol <i>valence e<sup>-</sup> only</i>
sodium	Na •
magnesium	•Mg•
aluminum	•Al•
silicon	•Si•
phosphorus	•P•
sulfur	:S•
chlorine	:Cl•
argon	:Ar:

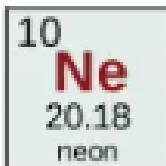
- Draw the lewis structure for sodium.
- Draw the lewis structure for helium.
- Draw the lewis structure for phosphorous.
- Draw the lewis structure for calcium.

# Octet Rule

## octet rule

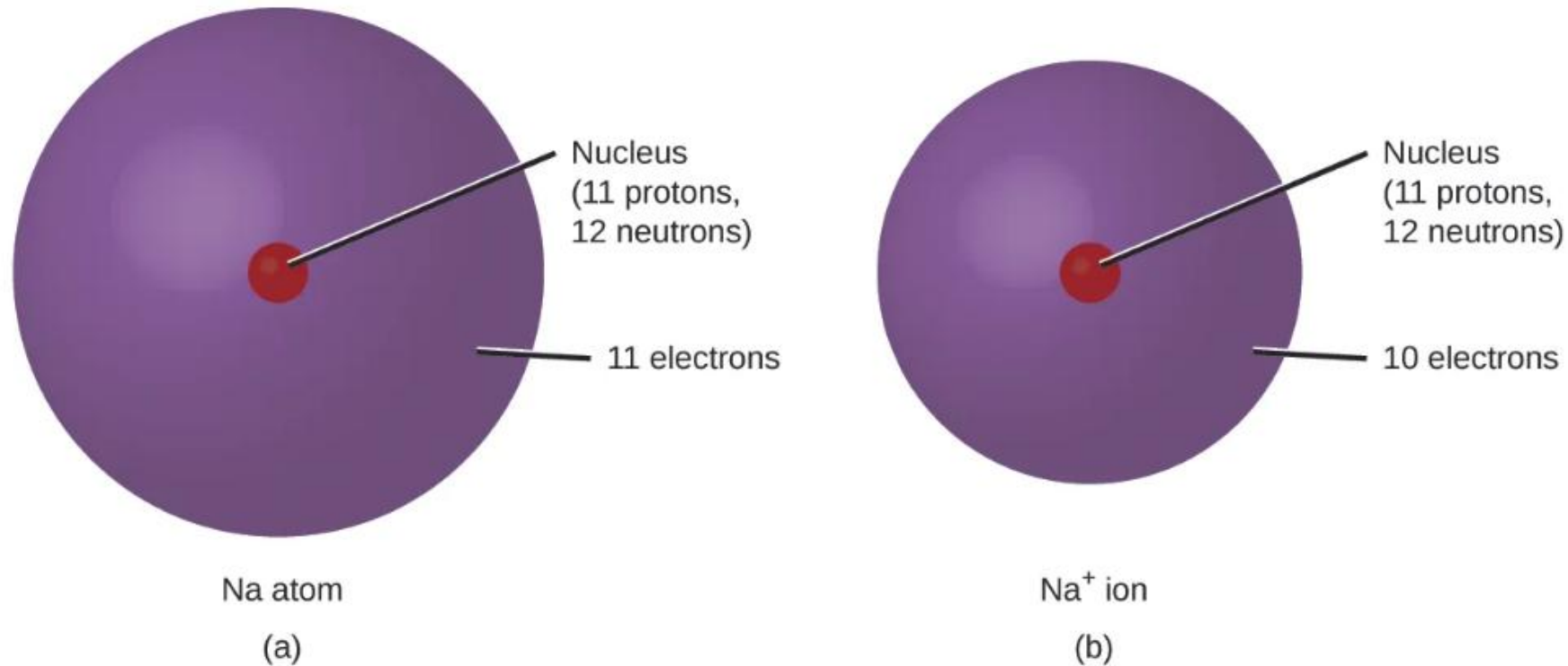
guideline that states main group atoms will form structures in which eight valence electrons interact with each nucleus, counting bonding electrons as interacting with both atoms connected by the bond

18



# Ionic Bonds (ionic compounds)

- Metal + Nonmetal
- Metal = gives away electrons, nonmetal = takes electrons



**Figure 3.39** (a) A sodium atom (Na) has equal numbers of protons and electrons (11) and is uncharged. (b) A sodium cation (Na<sup>+</sup>) has lost an electron, so it has one more proton (11) than electrons (10), giving it an overall positive charge, signified by a superscripted plus sign.

# The Periodic Table

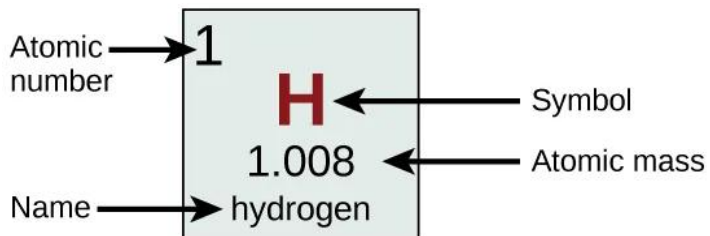
Period

Group  
1

## Periodic Table of the Elements

Color Code	
<span style="background-color: #f0f0f0; border: 1px solid black; display: inline-block; width: 15px; height: 15px;"></span> Metal	<b>Solid</b>
<span style="background-color: #e0e0e0; border: 1px solid black; display: inline-block; width: 15px; height: 15px;"></span> Metalloid	<b>Liquid</b>
<span style="background-color: #d0d0d0; border: 1px solid black; display: inline-block; width: 15px; height: 15px;"></span> Nonmetal	<b>Gas</b>

1	2											13	14	15	16	17	18
1 <b>H</b> 1.008 hydrogen																	2 <b>He</b> 4.003 helium
3 <b>Li</b> 6.94 lithium	4 <b>Be</b> 9.012 beryllium											5 <b>B</b> 10.81 boron	6 <b>C</b> 12.01 carbon	7 <b>N</b> 14.01 nitrogen	8 <b>O</b> 16.00 oxygen	9 <b>F</b> 19.00 fluorine	10 <b>Ne</b> 20.18 neon
11 <b>Na</b> 22.99 sodium	12 <b>Mg</b> 24.31 magnesium											13 <b>Al</b> 26.98 aluminum	14 <b>Si</b> 28.09 silicon	15 <b>P</b> 30.97 phosphorus	16 <b>S</b> 32.06 sulfur	17 <b>Cl</b> 35.45 chlorine	18 <b>Ar</b> 39.95 argon
19 <b>K</b> 39.10 potassium	20 <b>Ca</b> 40.08 calcium	21 <b>Sc</b> 44.96 scandium	22 <b>Ti</b> 47.87 titanium	23 <b>V</b> 50.94 vanadium	24 <b>Cr</b> 52.00 chromium	25 <b>Mn</b> 54.94 manganese	26 <b>Fe</b> 55.85 iron	27 <b>Co</b> 58.93 cobalt	28 <b>Ni</b> 58.69 nickel	29 <b>Cu</b> 63.55 copper	30 <b>Zn</b> 65.38 zinc	31 <b>Ga</b> 69.72 gallium	32 <b>Ge</b> 72.63 germanium	33 <b>As</b> 74.92 arsenic	34 <b>Se</b> 78.97 selenium	35 <b>Br</b> 79.90 bromine	36 <b>Kr</b> 83.80 krypton
37 <b>Rb</b> 85.47 rubidium	38 <b>Sr</b> 87.62 strontium	39 <b>Y</b> 88.91 yttrium	40 <b>Zr</b> 91.22 zirconium	41 <b>Nb</b> 92.91 niobium	42 <b>Mo</b> 95.95 molybdenum	43 <b>Tc</b> [97] technetium	44 <b>Ru</b> 101.1 ruthenium	45 <b>Rh</b> 102.9 rhodium	46 <b>Pd</b> 106.4 palladium	47 <b>Ag</b> 107.9 silver	48 <b>Cd</b> 112.4 cadmium	49 <b>In</b> 114.8 indium	50 <b>Sn</b> 118.7 tin	51 <b>Sb</b> 121.8 antimony	52 <b>Te</b> 127.6 tellurium	53 <b>I</b> 126.9 iodine	54 <b>Xe</b> 131.3 xenon
55 <b>Cs</b> 132.9 cesium	56 <b>Ba</b> 137.3 barium	57-71 <b>La-Lu</b> *	72 <b>Hf</b> 178.5 hafnium	73 <b>Ta</b> 180.9 tantalum	74 <b>W</b> 183.8 tungsten	75 <b>Re</b> 186.2 rhenium	76 <b>Os</b> 190.2 osmium	77 <b>Ir</b> 192.2 iridium	78 <b>Pt</b> 195.1 platinum	79 <b>Au</b> 197.0 gold	80 <b>Hg</b> 200.6 mercury	81 <b>Tl</b> 204.4 thallium	82 <b>Pb</b> 207.2 lead	83 <b>Bi</b> 209.0 bismuth	84 <b>Po</b> [209] polonium	85 <b>At</b> [210] astatine	86 <b>Rn</b> [222] radon
87 <b>Fr</b> [223] francium	88 <b>Ra</b> [226] radium	89-103 <b>Ac-Lr</b> **	104 <b>Rf</b> [267] rutherfordium	105 <b>Db</b> [270] dubnium	106 <b>Sg</b> [271] seaborgium	107 <b>Bh</b> [270] bohrium	108 <b>Hs</b> [277] hassium	109 <b>Mt</b> [276] meitnerium	110 <b>Ds</b> [281] darmstadtium	111 <b>Rg</b> [282] roentgenium	112 <b>Cn</b> [285] copernicium	113 <b>Nh</b> [285] nihonium	114 <b>Fl</b> [289] flerovium	115 <b>Mc</b> [288] moscovium	116 <b>Lv</b> [293] livermorium	117 <b>Ts</b> [294] tennessine	118 <b>Og</b> [294] oganesson



# The Periodic Table

Periodic Table of the Elements

Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8	Group 9	Group 10	Group 11	Group 12	Group 13	Group 14	Group 15	Group 16	Group 17	Group 18
Alkali metals	Alkaline earth metals	Transition metals												Pnictogens	Chalcogens	Halogens	Noble gases

The diagram illustrates the periodic table with the following group labels and categories:

- Group 1:** Alkali metals
- Group 2:** Alkaline earth metals
- Groups 3-12:** Transition metals
- Groups 13-17:** Main group elements, including Pnictogens (Group 15), Chalcogens (Group 16), and Halogens (Group 17).
- Group 18:** Noble gases

# Ionic Bonds

Periodic Table of the Elements

Period	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8	Group 9	Group 10	Group 11	Group 12	Group 13	Group 14	Group 15	Group 16	Group 17	Group 18
1	H <sup>+</sup>																	He
2	Li <sup>+</sup>	Be <sup>2+</sup>											B <sup>3+</sup>		N <sup>3-</sup>	O <sup>2-</sup>	F <sup>-</sup>	Ne
3	Na <sup>+</sup>	Mg <sup>2+</sup>											Al <sup>3+</sup>		P <sup>3-</sup>	S <sup>2-</sup>	Cl <sup>-</sup>	Ar
4	K <sup>+</sup>	Ca <sup>2+</sup>										Zn <sup>2+</sup>			As <sup>3-</sup>	Se <sup>2-</sup>	Br <sup>-</sup>	Kr
5	Rb <sup>+</sup>	Sr <sup>2+</sup>									Ag <sup>+</sup>					Te <sup>2-</sup>	I <sup>-</sup>	Xe
6	Cs <sup>+</sup>	Ba <sup>2+</sup>															At <sup>-</sup>	Rn
7	Fr <sup>+</sup>	Ra <sup>2+</sup>																

# Polyatomic Ions

Name	Formula
ammonium	$\text{NH}_4^+$
hydronium	$\text{H}_3\text{O}^+$
peroxide	$\text{O}_2^{2-}$
hydroxide	$\text{OH}^-$
acetate	$\text{CH}_3\text{COO}^-$
cyanide	$\text{CN}^-$
azide	$\text{N}_3^-$
carbonate	$\text{CO}_3^{2-}$
bicarbonate	$\text{HCO}_3^-$
nitrate	$\text{NO}_3^-$
nitrite	$\text{NO}_2^-$
sulfate	$\text{SO}_4^{2-}$

Name	Formula
hydrogen sulfate	$\text{HSO}_4^-$
sulfite	$\text{SO}_3^{2-}$
hydrogen sulfite	$\text{HSO}_3^-$
phosphate	$\text{PO}_4^{3-}$
hydrogen phosphate	$\text{HPO}_4^{2-}$
dihydrogen phosphate	$\text{H}_2\text{PO}_4^-$
perchlorate	$\text{ClO}_4^-$
chlorate	$\text{ClO}_3^-$
chlorite	$\text{ClO}_2^-$
hypochlorite	$\text{ClO}^-$
chromate	$\text{CrO}_4^{2-}$
dichromate	$\text{Cr}_2\text{O}_7^{2-}$
permanganate	$\text{MnO}_4^-$

# Ions

## Check Your Learning

Aluminum and carbon react to form an ionic compound. Predict which forms an anion, which forms a cation, and the charges of each ion. Write the symbol for each ion and name them.

# Ionic Bonds

Metal		Nonmetal		Ionic Compound
$\text{Na} \cdot$ sodium atom	+	$\cdot \ddot{\text{Cl}} \cdot$ chlorine atom	$\longrightarrow$	$\text{Na}^+ \left[ \ddot{\text{Cl}} \right]^-$ sodium chloride (sodium ion and chloride ion)
$\cdot \text{Mg} \cdot$ magnesium atom	+	$\cdot \ddot{\text{O}} \cdot$ oxygen atom	$\longrightarrow$	$\text{Mg}^{2+} \left[ \ddot{\text{O}} \right]^{2-}$ magnesium oxide (magnesium ion and oxide ion)
$\cdot \text{Ca} \cdot$ calcium atom	+	$2 \cdot \ddot{\text{F}} \cdot$ fluorine atoms	$\longrightarrow$	$\text{Ca}^{2+} \left[ \ddot{\text{F}} \right]_2^-$ calcium fluoride (calcium ion and two fluoride ions)

**Figure 4.11** Cations are formed when atoms lose electrons, represented by fewer Lewis dots, whereas anions are formed by atoms gaining electrons. The total number of electrons does not change.

# Ionic Bonds

- Make neutral compounds
- The charges of the ions should add up to 0.
- You can't change the charge of the ions but you can just “find” additional ions with the same charge so the charges add up to 0.

# Ionic Bonds

**KF**

**Li<sub>2</sub>S**

**BaBr<sub>2</sub>**

# Ionic Bonds

## Check Your Learning

Predict the formula of the ionic compound formed between the sodium cation,  $\text{Na}^+$ , and the sulfide anion,  $\text{S}^{2-}$ .

# Ionic Bonds

## Check Your Learning

Predict the formula of the ionic compound formed between the lithium ion and the peroxide ion,  $\text{O}_2^{2-}$   
(Hint: Use the periodic table to predict the sign and the charge on the lithium ion.)

# Ionic Bonds

- Ionic compounds
  - Held together by ionic bonds (+/- charges)
  - Ionic bonds are formed by atoms giving and taking electrons
  - Occurs between metals and nonmetals
  - Usually comes apart in water

# Lewis Structures and Covalent Bonds

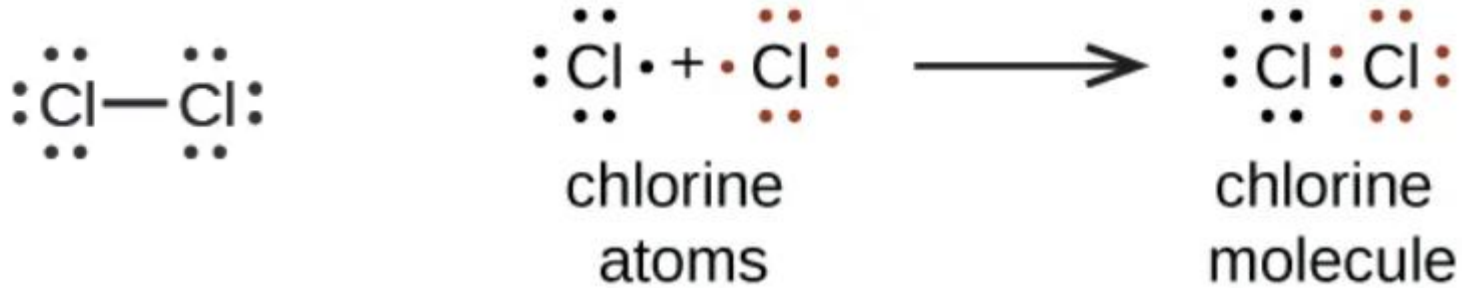
- Chapter 4.4 (Lewis Symbols and Structures)
- Chapter 3.7 (Ionic and Molecular Compounds)

# Ionic Bonds and Covalent Bonds

- Ionic compounds
  - Held together by ionic bonds (+/- charges)
  - Ionic bonds are formed by atoms giving and taking electrons
  - Occurs between metals and nonmetals
  - Usually comes apart in water.
- Molecular compounds
  - Held together by covalent bonds
  - Covalent bonds are formed by atoms sharing electrons
  - Occurs between two nonmetals
  - Usually doesn't come apart in water

# Covalent Bonds (molecular compounds)

- Nonmetal + Nonmetal
- nonmetal = takes electrons
- Two nonmetals = sharing electrons



# Covalent Bonds and Lewis Structures

1. Determine the total number of valence (outer shell) electrons. For cations, subtract one electron for each positive charge. For anions, add one electron for each negative charge.
2. Draw a skeleton structure of the molecule or ion, arranging the atoms around a central atom. (Generally, the least electronegative element should be placed in the center.) Connect each atom to the central atom with a single bond (one electron pair).
3. Distribute the remaining electrons as lone pairs on the terminal atoms (except hydrogen), completing an octet around each atom.
4. Place all remaining electrons on the central atom.
5. Rearrange the electrons of the outer atoms to make multiple bonds with the central atom in order to obtain octets wherever possible.

# Covalent Bonds and Lewis Structures (com's way)

- Count total valence electrons of all atoms
  - Negative charges mean add electrons, positive charges mean subtract electrons
- Draw the skeletal structure with these tips
  - symmetrical
  - H, F, Cl, Br, I on the outsides
- Place bonding electrons in pairs to connect atoms
- Put rest of electrons on the outsides in pairs following the “octet” rule
  - If an atom doesn't have all it's electrons, share your neighbor's electron pairs
- Other common things (usual but not always):
  - C = 4 bonds, 0 lone pair
  - N = 3 bonds, 1 lone pair
  - O = 2 bonds, 2 lone pairs
  - halogens = 1 bond, 3 lone pairs

# Covalent Bonds and Lewis Structures

- Count total valence electrons of all atoms
  - Negative charges mean add electrons, positive charges mean subtract electrons
- Draw the skeletal structure with these tips
  - symmetrical
  - H, F, Cl, Br, I on the outsides
- Place bonding electrons in pairs to connect atoms
- Put rest of electrons on the outsides in pairs following the “octet” rule
  - If an atom doesn't have all its electrons, share your neighbor's electron pairs
- Other common things (usual but not always):
  - C = 4 bonds, 0 lone pair
  - N = 3 bonds, 1 lone pair
  - O = 2 bonds, 2 lone pairs
  - halogens = 1 bond, 3 lone pairs



# Covalent Bonds and Lewis Structures

- Count total valence electrons of all atoms
  - Negative charges mean add electrons, positive charges mean subtract electrons
- Draw the skeletal structure with these tips
  - symmetrical
  - H, F, Cl, Br, I on the outsides
- Place bonding electrons in pairs to connect atoms
- Put rest of electrons on the outsides in pairs following the “octet” rule
  - If an atom doesn't have all its electrons, share your neighbor's electron pairs
- Other common things (usual but not always):
  - C = 4 bonds, 0 lone pair
  - N = 3 bonds, 1 lone pair
  - O = 2 bonds, 2 lone pairs
  - halogens = 1 bond, 3 lone pairs

CO

CO<sub>2</sub>

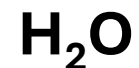
# Covalent Bonds and Lewis Structures

- Count total valence electrons of all atoms
  - Negative charges mean add electrons, positive charges mean subtract electrons
- Draw the skeletal structure with these tips
  - symmetrical
  - H, F, Cl, Br, I on the outsides
- Place bonding electrons in pairs to connect atoms
- Put rest of electrons on the outsides in pairs following the “octet” rule
  - If an atom doesn't have all its electrons, share your neighbor's electron pairs
- Other common things (usual but not always):
  - C = 4 bonds, 0 lone pair
  - N = 3 bonds, 1 lone pair
  - O = 2 bonds, 2 lone pairs
  - halogens = 1 bond, 3 lone pairs



# Covalent Bonds and Lewis Structures

- Count total valence electrons of all atoms
  - Negative charges mean add electrons, positive charges mean subtract electrons
- Draw the skeletal structure with these tips
  - symmetrical
  - H, F, Cl, Br, I on the outsides
- Place bonding electrons in pairs to connect atoms
- Put rest of electrons on the outsides in pairs following the “octet” rule
  - If an atom doesn't have all its electrons, share your neighbor's electron pairs
- Other common things (usual but not always):
  - C = 4 bonds, 0 lone pair
  - N = 3 bonds, 1 lone pair
  - O = 2 bonds, 2 lone pairs
  - halogens = 1 bond, 3 lone pairs



# Ionic and Molecular Compounds

## Check Your Learning

Using the periodic table, predict whether the following compounds are ionic or covalent:

(a)  $\text{SO}_2$

(b)  $\text{CaF}_2$

(c)  $\text{N}_2\text{H}_4$

(d)  $\text{Al}_2(\text{SO}_4)_3$

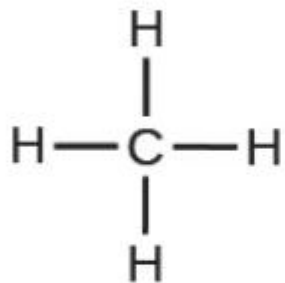
# Molecules, Compounds, and Chemical Formulas

- Chapter 2.4 (Chemical Formulas)
- Chapter 3.6 (The Periodic Table)
- Chapter 1.2 (Phases and Classifications of Matter)

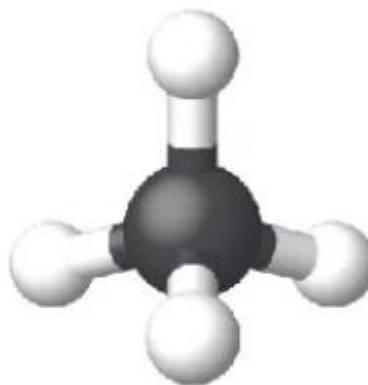
# Chemical Formulas



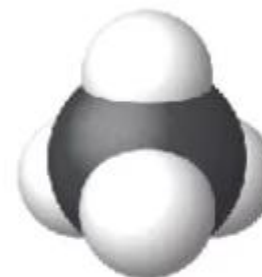
(a)



(b)



(c)



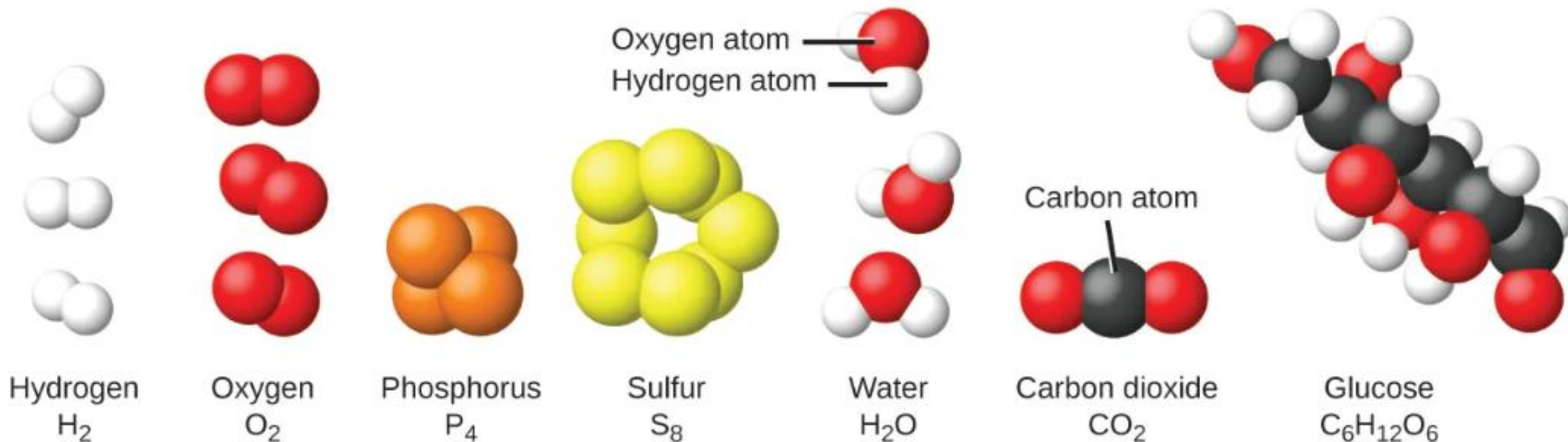
(d)

**Figure 2.16** 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.



# Molecules and Compounds

**Compounds**  
(two or more different atoms)



**Figure 1.14** The elements hydrogen, oxygen, phosphorus, and sulfur form molecules consisting of two or more atoms of the same element. The compounds water, carbon dioxide, and glucose consist of combinations of atoms of different elements.

**molecules**  
(more than one atom)

# What are things called?

- **Atoms/elements**
- **Molecules (more than one atom)**
- **Compounds (two or more different atoms)**
- **Molecular Element (multiple of the same atom)**
- **Molecular Compound (two different nonmetals)**
- **Ionic Compound (metal and a nonmetal)**

1. **What is He?**
2. **What is NO?**
3. **What is H<sub>2</sub>O?**
4. **What is Fe?**
5. **What is H<sub>2</sub>?**
6. **What is NaCl**

# Chemical Formulas

- Subscript numbers (small and to the bottom right) is just for what is immediately to the left of it. If there are parentheses it's the number of things in the parentheses
- Number on the left of molecule is the coefficient and tells you how many total molecules there are

H

H<sub>2</sub>

H<sub>2</sub>O

H<sub>2</sub>O<sub>2</sub>

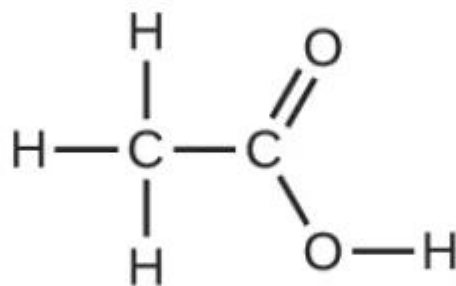
2(H<sub>2</sub>O<sub>2</sub>)

2(NH<sub>4</sub>)<sub>2</sub>(SO<sub>4</sub>)

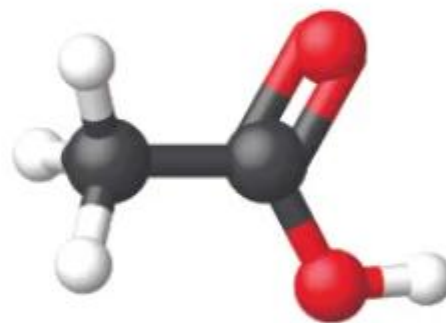
# Molecular vs Empirical Formula



(a)



(b)



(c)

**Figure 2.21** (a) Vinegar contains acetic acid,  $C_2H_4O_2$ , 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. (credit a: modification of work by "HomeSpot HQ"/Flickr)

# Molecular vs Empirical Formula

Molecular Formula

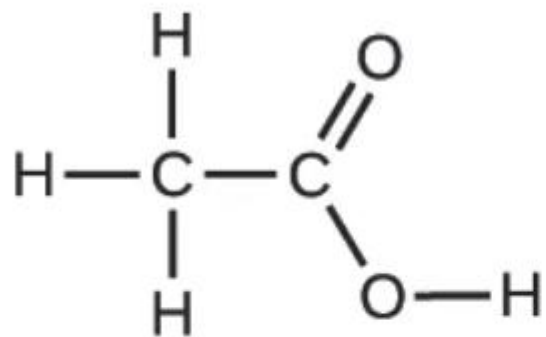
Empirical Formula

# Molecular vs Empirical Formula

## Check Your Learning

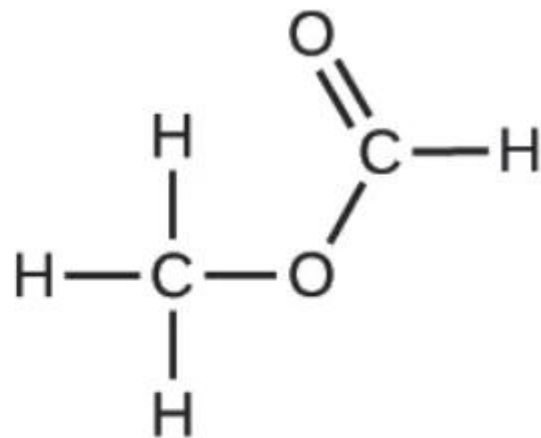
A molecule of metaldehyde (a pesticide used for snails and slugs) contains 8 carbon atoms, 16 hydrogen atoms, and 4 oxygen atoms. What are the molecular and empirical formulas of metaldehyde?

# Isomers



Acetic acid  
 $C_2H_4O_2$

(a)

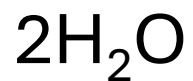
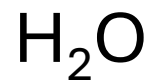


Methyl formate  
 $C_2H_4O_2$

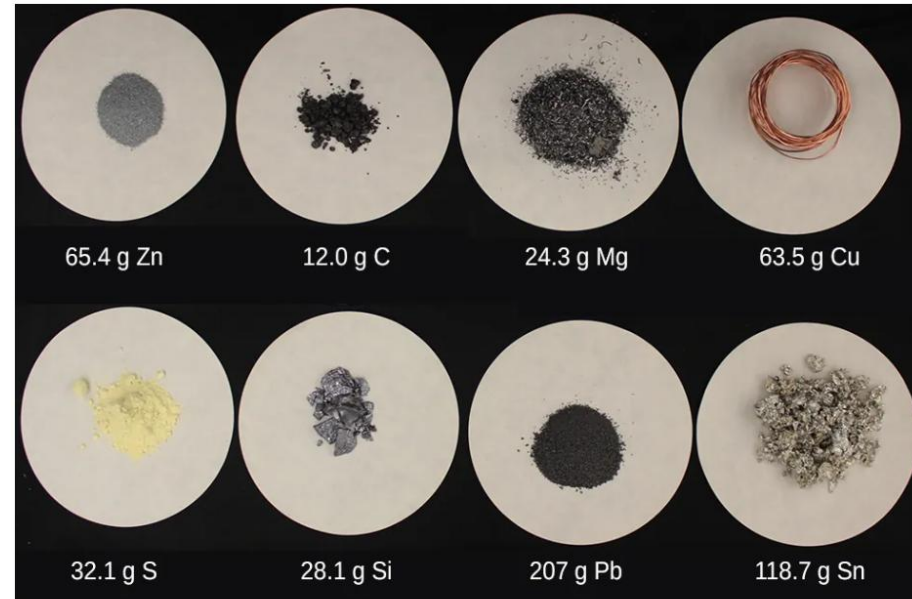
(b)

**Figure 2.23** Molecules of (a) acetic acid and methyl formate (b) are structural isomers; they have the same formula ( $C_2H_4O_2$ ) but different structures (and therefore different chemical properties).

# Grams Per Mole!



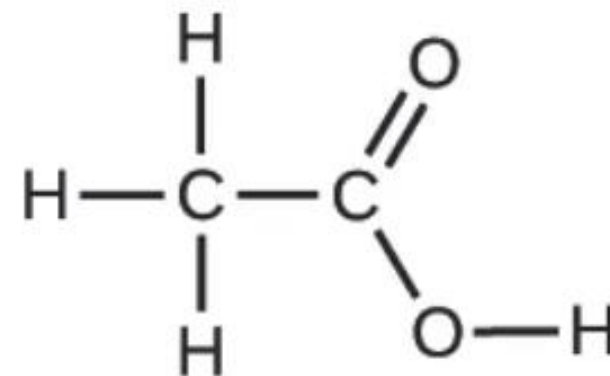
Element	Average Atomic Mass (amu)	Molar Mass (g/mol)	Atoms/Mole
C	12.01	12.01	$6.022 \times 10^{23}$
H	1.008	1.008	$6.022 \times 10^{23}$
O	16.00	16.00	$6.022 \times 10^{23}$
Na	22.99	22.99	$6.022 \times 10^{23}$
Cl	35.45	35.45	$6.022 \times 10^{23}$



**Figure 2.25** Each sample contains  $6.022 \times 10^{23}$  atoms — 1.00 mol of atoms. From left to right (top row): 65.4 g zinc, 12.0 g carbon, 24.3 g magnesium, and 63.5 g copper. From left to right (bottom row): 32.1 g sulfur, 28.1 g silicon, 207 g lead, and 118.7 g tin. (credit: modification of work by Mark Ott)

# Grams Per Mole of Molecules

Period	Group	1	2	13	14	15	16	17	18
1		1 <b>H</b> 1.008 hydrogen							2 <b>He</b> 4.003 helium
2		3 <b>Li</b> 6.94 lithium	4 <b>Be</b> 9.012 beryllium	5 <b>B</b> 10.81 boron	6 <b>C</b> 12.01 carbon	7 <b>N</b> 14.01 nitrogen	8 <b>O</b> 16.00 oxygen	9 <b>F</b> 19.00 fluorine	10 <b>Ne</b> 20.18 neon



Acetic acid  
 $C_2H_4O_2$

# Grams Per Mole of Molecules

Calculate Grams Per Mole for the empirical and molecular formula.

Period	Group								
1	1	1 <b>H</b> 1.008 hydrogen	2	13	14	15	16	17	18 2 <b>He</b> 4.003 helium
2		3 <b>Li</b> 6.94 lithium	4 <b>Be</b> 9.012 beryllium	5 <b>B</b> 10.81 boron	6 <b>C</b> 12.01 carbon	7 <b>N</b> 14.01 nitrogen	8 <b>O</b> 16.00 oxygen	9 <b>F</b> 19.00 fluorine	10 <b>Ne</b> 20.18 neon

## Check Your Learning

A molecule of metaldehyde (a pesticide used for snails and slugs) contains 8 carbon atoms, 16 hydrogen atoms, and 4 oxygen atoms. What are the molecular and empirical formulas of metaldehyde?