



Module 4

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BIOC 141

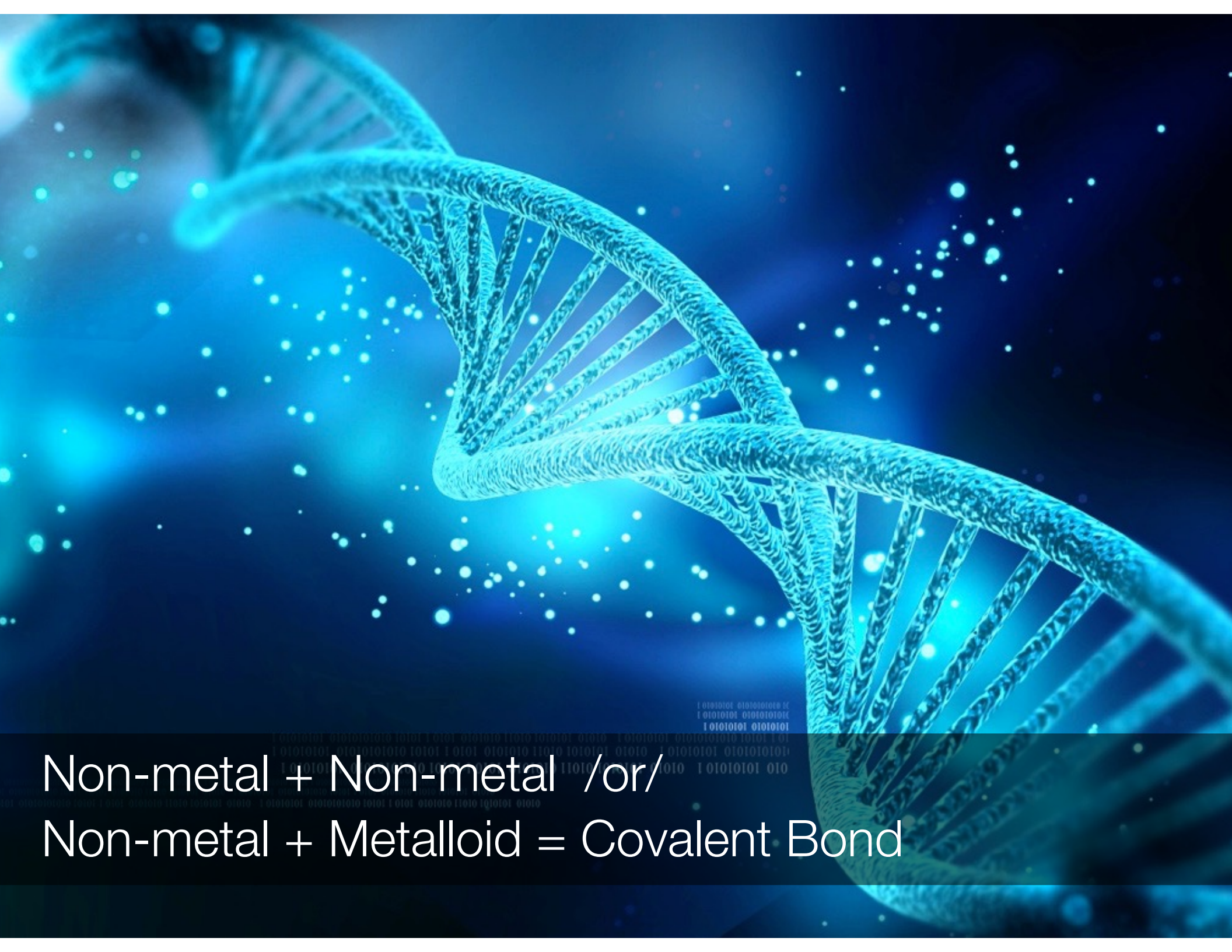
Chemical Bonds (Section 3.1)



a very strong attraction
between two atoms

Metal + Non-metal = Ionic Bond





Non-metal + Non-metal /or/
Non-metal + Metalloid = Covalent Bond

Concept Check

Predict whether each compound below has **ionic** or **covalent** bonds:

NaF **ionic** or **covalent**

C₁₂H₂₂O₁₁ **ionic** or **covalent**

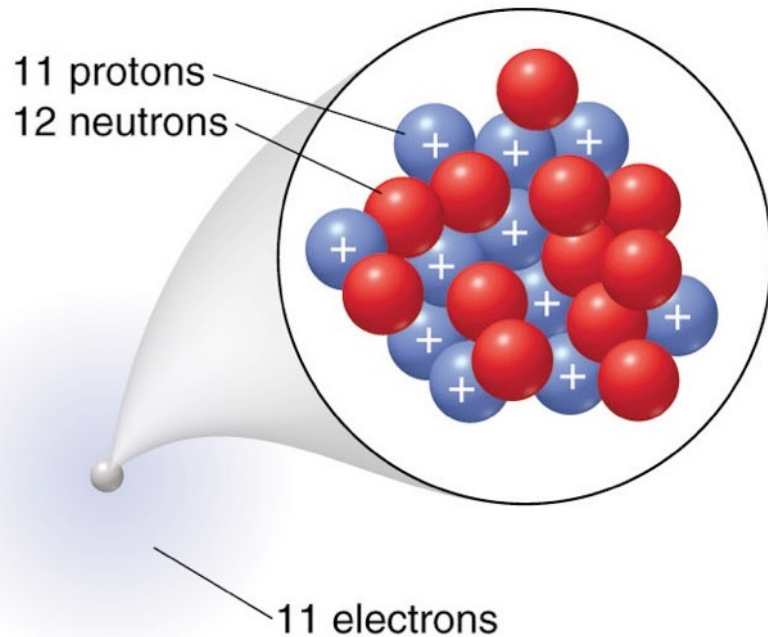
CO₂ **ionic** or **covalent**

CaCl₂ **ionic** or **covalent**



Ions are charged species that have **unequal** amounts of protons and electrons.

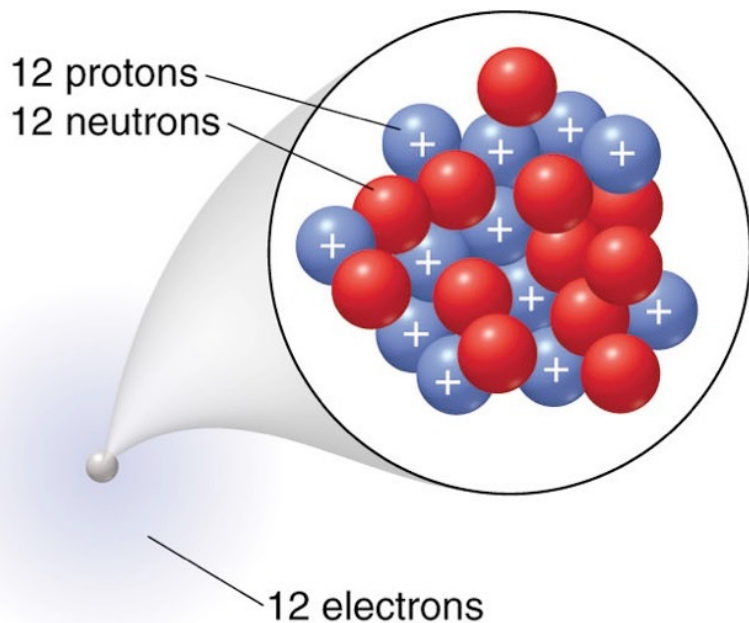
Cations are positively charged ions



Na atom

Na⁺ cation

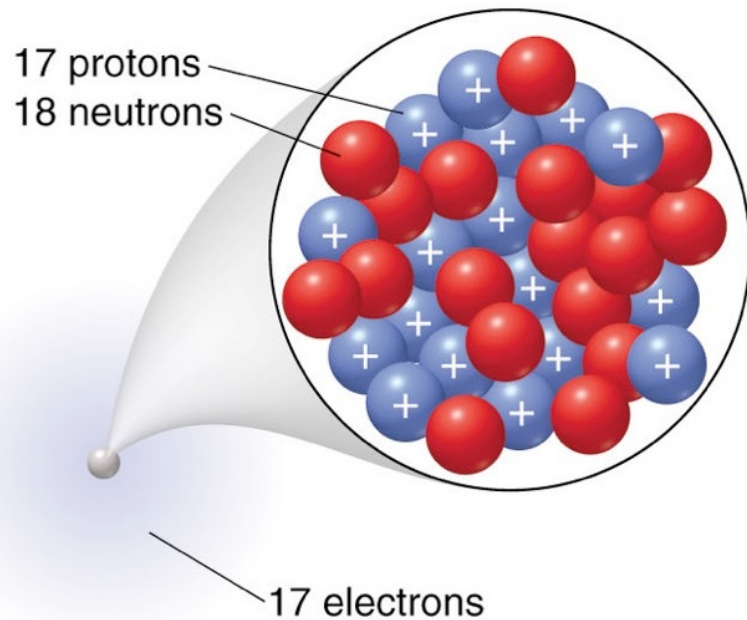
Cations are positively charged ions



Mg atom

Mg²⁺ cation

Anions are negatively charged ions.



Cl atom

Cl⁻ anion

Concept Check

Write the **ion symbol** for an ion with 19 protons and 18 electrons

Write the **ion symbol** for an ion with 7 protons and 10 electrons

The Octet Rule



A main group element obtains **maximum stability** when it has an **octet of electrons** in its valence shell.

Concept Review (Section 3.1)

CONCEPT REVIEW EXERCISES

1. What is the octet rule?
2. How are ionic bonds formed?

Practice Problems: 1-6

Easier to lose e-'s

For Groups 1A, 2A and 3A
Cation charge = Group number

Group Number and Ionic Charge

Easier to gain

1A 1																	2A 2	3A 13	4A 14	5A 15	6A 16	7A 17	2 He Helium 4.00260
1 H Hydrogen 1.00794																							
3 Li Lithium 6.941	4 Be Beryllium 9.01218															5 B Boron 10.811	6 C Carbon 12.011	7 N Nitrogen 14.0067	8 O Oxygen 15.9994	9 F Fluorine 18.998403	10 Ne Neon 20.1797		
11 Na Sodium 22.98977	12 Mg Magnesium 24.305	3B 3	4B 4	5B 5	6B 6	7B 7	8B 8 9 10			1B 11	2B 12	13 Al Aluminum 26.98154	14 Si Silicon 28.0855	15 P Phosphorus 30.97376	16 S Sulfur 32.066	17 Cl Chlorine 35.4527	18 Ar Argon 39.948						
19 K Potassium 39.0983	20 Ca Calcium 40.078	21 Sc Scandium 44.9559	22 Ti Titanium 47.88	23 V Vanadium 50.9415	24 Cr Chromium 51.9961	25 Mn Manganese 54.9380	26 Fe Iron 55.847	27 Co Cobalt 58.9332	28 Ni Nickel 58.6934	29 Cu Copper 63.546	30 Zn Zinc 65.39	31 Ga Gallium 69.723	32 Ge Germanium 72.61	33 As Arsenic 74.9216	34 Se Selenium 78.96	35 Br Bromine 79.904	36 Kr Krypton 83.80						
37 Rb Rubidium 85.4678	38 Sr Strontium 87.62	39 Y Yttrium 88.9059	40 Zr Zirconium 91.224	41 Nb Niobium 92.9064	42 Mo Molybdenum 95.94	43 Tc Technetium [98]	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.9055	46 Pd Palladium 106.42	47 Ag Silver 107.8682	48 Cd Cadmium 112.411	49 In Indium 114.82	50 Sn Tin 118.710	51 Sb Antimony 121.757	52 Te Tellurium 127.60	53 I Iodine 126.9045	54 Xe Xenon 131.29						
55 Cs Cesium 132.9054	56 Ba Barium 137.327	*57 La Lanthanum 138.9055	72 Hf Hafnium 178.49	73 Ta Tantalum 180.9479	74 W Tungsten 183.85	75 Re Rhenium 186.207	76 Os Osmium 190.2	77 Ir Iridium 192.22	78 Pt Platinum 195.08	79 Au Gold 196.9665	80 Hg Mercury 200.59	81 Tl Thallium 204.3833	82 Pb Lead 207.2	83 Bi Bismuth 208.9804	84 Po Polonium [209]	85 At Astatine [210]	86 Rn Radon [222]						
87 Fr Francium [223]	88 Ra Radium 226.0254	†89 Ac Actinium 227.0278	104 Rf Rutherfordium [261]	105 Db Dubnium [262]	106 Sg Seaborgium [263]	107 Bh Bohrium [262]	108 Hs Hassium [265]	109 Mt Meitnerium [268]	110 [269]	111 [272]	112 [277]												

Easier to gain

For Groups 4A thru 7A
Anion charge = 8 - Group number

Concept Check

Determine the charge on each ion formed from the following elements

Mg

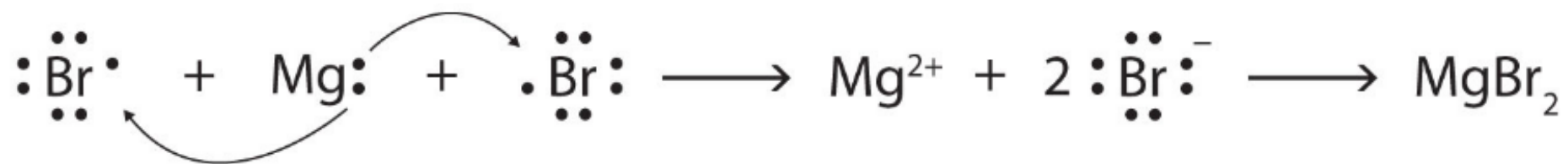
Al

I

P

Se

Lewis Diagrams for Electron Transfer



Concept Review (Section 3.2)

CONCEPT REVIEW EXERCISES

1. What are the two types of ions?
2. Use Lewis diagrams to illustrate the formation of an ionic compound from a potassium atom and an iodine atom.
3. When the following atoms become ions, what charges do they acquire?
 - a. Li
 - b. S
 - c. Ca
 - d. F

Practice Problems: 1, 2, 5-14

Writing Chemical Formulas (Section 3.3)

Cation first and anion second

Don't show charges in the formula

Subscripts indicate the number of each ion

No subscript is assumed to be “1”

Examples:

Mg and O

Al and S

Writing Chemical Formulas

Key Point!

The **sum** of the charges in an ionic compound **must equal zero**.

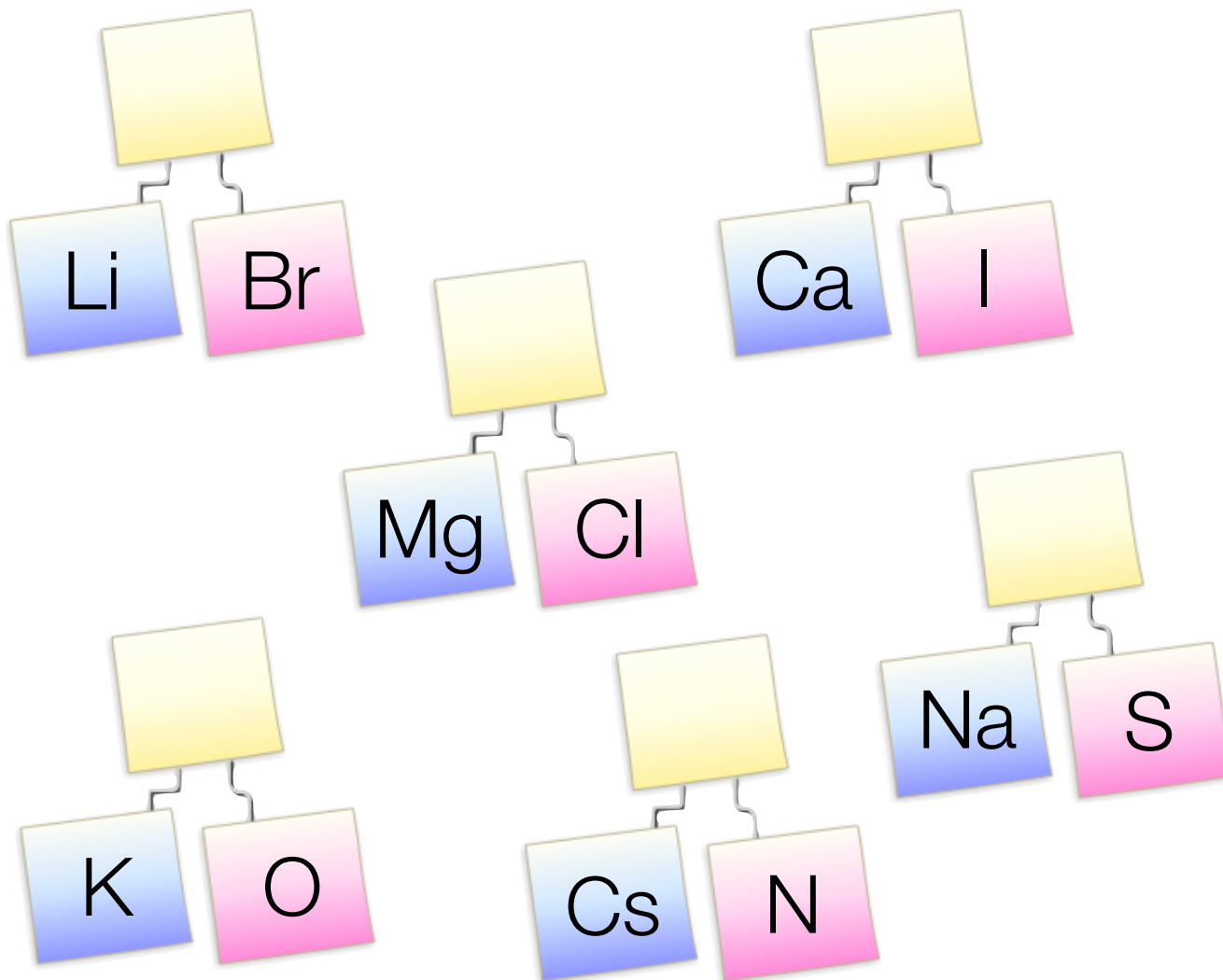
Examples:

Mg and O

Al and S

Concept Check

Write the formula for the compound formed from each pair



Polyatomic Ions

A polyatomic ion is a cation or anion that contains more than one atom.

Held together by covalent bonds

Behave like regular cations or anions

Polyatomic Ions

Ion	Name	Ion	Name
NH_4^+	ammonium	CO_3^{2-}	carbonate
NO_2^-	nitrite	HCO_3^-	hydrogen carbonate or bicarbonate
NO_3^-	nitrate	ClO^-	hypochlorite
SO_3^{2-}	sulfite	ClO_2^-	chlorite
SO_4^{2-}	sulfate	ClO_3^-	chlorate
HSO_4^-	hydrogen sulfate	ClO_4^-	perchlorate
OH^-	hydroxide	$\text{C}_2\text{H}_3\text{O}_2^-$	acetate
CN^-	cyanide	MnO_4^-	permanganate
PO_4^{3-}	phosphate	$\text{Cr}_2\text{O}_7^{2-}$	dichromate
HPO_4^{2-}	hydrogen phosphate	CrO_4^{2-}	chromate
H_2PO_4^-	<u>dihydrogen</u> phosphate	O_2^{2-}	peroxide

Writing Chemical Formulas

If more than one **polyatomic ion** is needed,
use **parentheses** with subscripts

Examples:

barium sulfate

aluminum carbonate

Naming w/Polyatomic Ions



Concept Review (Section 3.3)

CONCEPT REVIEW EXERCISES

1. What information is contained in the formula of an ionic compound?
2. Why do the chemical formulas for some ionic compounds contain subscripts, while others do not?
3. Write the chemical formula for the ionic compound formed by each pair of ions.
 - a. Mg^{2+} and I^{-}
 - b. Na^{+} and O^{2-}

Practice Problems: 1-12

Ionic Nomenclature (Section 3.4)

Main group cations = element name



Variable-charge cations = element name
followed by a **Roman numeral** in parentheses



Cations from Variable Charge Metals

All transition metals + Sn + Pb

All transition metals + Sn + Pb

The periodic table shows the following elements highlighted in yellow:

- Transition Metals (d-block):** Scandium (Sc), Titanium (Ti), Vanadium (V), Chromium (Cr), Manganese (Mn), Iron (Fe), Cobalt (Co), Nickel (Ni), Copper (Cu), Zinc (Zn), Yttrium (Y), Zirconium (Zr), Niobium (Nb), Molybdenum (Mo), Technetium (Tc), Ruthenium (Ru), Rhodium (Rh), Palladium (Pd), Silver (Ag), Cadmium (Cd), Lanthanum (La), Hafnium (Hf), Tantalum (Ta), Tungsten (W), Rhenium (Re), Osmium (Os), Iridium (Ir), Platinum (Pt), Gold (Au), Mercury (Hg), Rutherfordium (Rf), Dubnium (Db), Seaborgium (Sg), Bohrium (Bh), Hassium (Hs), Meitnerium (Mt).
- Other Highlighted Elements:** Tin (Sn) and Lead (Pb).

Naming Anions

Replace the ending of the element with “-ide.”

TABLE 3.4 Names of Common Anions		
Element	Ion Symbol	Name
Bromine	Br^-	Bromide
Chlorine	Cl^-	Chloride
Fluorine	F^-	Fluoride
Iodine	I^-	Iodide
Oxygen	O^{2-}	Oxide
Sulfur	S^{2-}	Sulfide

Concept Check

Give the name for each ion symbol:

- Cu^+
- N^{3-}
- Cs^+
- Pt^{2+}
- Al^{3+}
- P^{3-}

Give the ion symbol for each name:

- lead (II)
- oxide
- tin (IV)
- selenide
- nitride
- iron (III)

Writing Chemical Names

Cation first and anion second

Don't show charges in the name

Don't show subscripts in the name

Examples:



Compounds with Variable-charge Metals

Must indicate **charge of cation** in name.

Examples:

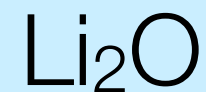
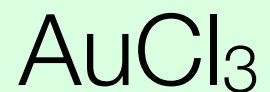
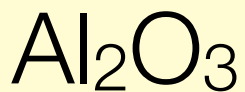




Titanium (IV) oxide

Concept Check

Name each compound



Concept Review (Section 3.4)

CONCEPT REVIEW EXERCISES

1. Briefly describe the process for naming an ionic compound.
2. In what order do the names of ions appear in the names of ionic compounds?
3. Which ionic compounds can be named using two different systems? Give an example.

Practice Problems: 1-12