

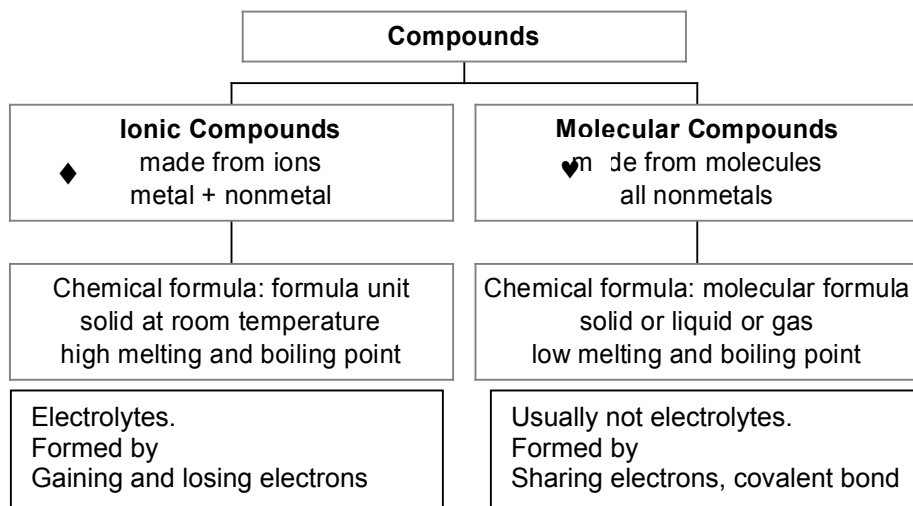
Name _____ Date _____ Period _____

“Need to know” Summary Chapter 5.1 Ionic Compounds**Objectives**

Describe molecular and ionic compounds and write formulas and names for ionic and molecular compounds.

Molecular and Ionic Compounds

Compounds are substances composed of two or more different elements chemically combined. They can be either molecular compounds or ionic compounds.

**Chemical Formulas**

A **Chemical Formula** shows the kinds and numbers of atoms present in the smallest representative unit of the substance. (Most general term, applies for any compound or element)

♦ A **Formula Unit**, (NaCl, MgCl₂ etc.)

the chemical formula of an ionic compound, is the **lowest** whole-number ratio of ions in an **ionic compound**.

♥ A **Molecular Formula** (NH₃, H₂O, C₂H₄ etc.)

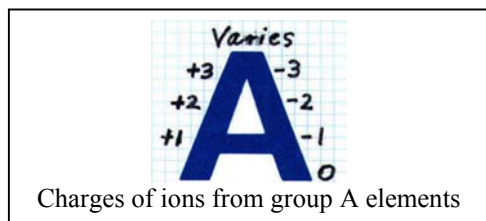
shows the kinds and numbers of atoms present in a **molecule** of a **molecular compound**.

♦ Names and Formulas of Ionic Compounds

Ionic charges (Oxidation numbers)

Metallic elements tend to lose electrons and form _____ (with a positive charge)

Nonmetallic elements tend to gain electrons and form _____ (with a negative charge)

**Ionic Charges (Oxidation numbers) of Main group Elements**

1A	2A	3A	4A	5A	6A	7A	8A
Li ⁺	Be ²⁺			N ³⁻	O ²⁻	F ⁻	He
Na ⁺	Mg ²⁺	Al ³⁺		P ³⁻	S ²⁻	Cl ⁻	Ne
K ⁺	Ca ²⁺				Se ²⁻	Br ⁻	Ar
Rb ⁺	Sr ²⁺					I ⁻	Kr
Cs ⁺	Ba ²⁺						
+1	+2	+3	varies	-3	-2	-1	0

Most transition metals (groups B) form more than one ionic charge, as do the metals tin and lead in group 4A. They “vary”.

Practice Problems:

2) What is the charge of the ions formed from the following elements

- a) phosphorous P
- b) chlorine Cl
- c) calcium Ca
- d) neon Ne
- e) oxygen O

1) Write on top of each group the charge of the ions

1	2											13	14	15	16	17	18								
1A	2A											3A	4A	5A	6A	7A	8A								
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18								
H	He											B	C	N	O	F	Ne								
Li	Be											Al	Si	P	S	Cl	Ar								
Na	Mg	III B	IV B	V B	VIB	VII B	VIII B			IB	IIB	Ga	Ge	As	Se	Br	Kr								
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	31	32	33	34	35	36								
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	49	50	51	52	53	54								
Cs	Ba	Lu	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	81	82	83	84	85	86								
Fr	Ra	103	104	105	106	107	108	109																	
												57	58	59	60	61	62	63	64	65	66	67	68	69	70
												La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb
												89	90	91	92	93	94	95	96	97	98	99	100	101	102
												Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No

3. What is the charge of ions in the following groups of the periodic table?

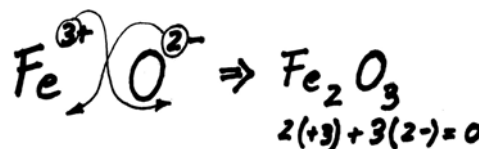
Select from: 0, -1, -2, -3, +1, +2, +3, or varies.

	IA	IIA	IIIA	IVA	VA	VIA	VIIA	VIIIA	I-VIII B
Charge									

Binary Compounds are composed of two elements (examples: NaCl, AlCl₃)

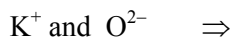
Writing Formulas of Binary Ionic Compounds

- The net ionic charge of the formula must be zero.
- Use criss-cross method to determine the formula (Write numbers diagonal as subscript without the charge)
- Check for **smallest** whole-number ratio



Crisscross method to balance an ionic formula

Practice problems: Criss cross and write the correct formula

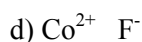
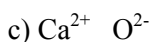
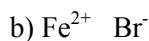
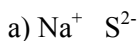


Naming Binary Ionic Compounds

- Always write cation first, anion last
- The name of the cation is the same as the name of the element.
- The name of a monoatomic anion ends in *-ide*.
- For Metal cations of Transition elements (the B groups) and group 4A (whenever charge can vary...) use a roman numeral in parenthesis after the cation's name to indicate the charge.
e.g. Fe²⁺ is iron (II) ion, Fe³⁺ is iron (III) ion; Fe³⁺ and Cl⁻ ⇒ Iron (III) chloride

Practice problems

Write the names of ionic compounds made from the following ions:



Ternary ionic compounds

Ternary ionic compounds are made of three or more different elements. Usually containing a polyatomic ion.

Polyatomic Ions are tightly bound groups of atoms that behave as a unit and carry a charge

formula (1-)	Name (1-)	formula (2-)	Name (2-)
$C_2H_3O_2^-$	Acetate	CO_3^{2-}	Carbonate*
NO_2^-	Nitrite	$C_2O_4^{2-}$	Oxalate
NO_3^-	Nitrate*	SO_3^{2-}	Sulfite
CN^-	Cyanide*	SO_4^{2-}	Sulfate*
OH^-	Hydroxide*	CrO_4^{2-}	Chromate
MnO_4^-	Permanganate	formula (3-)	Name (3-)
ClO^-	Hypochlorite	PO_4^{3-}	Phosphate*
ClO_2^-	Chlorite	PO_3^{3-}	Phosphite
ClO_3^-	Chlorate	formula (1+)	Name (1+)
ClO_4^-	Perchlorate	NH_4^+	Ammonium*

Names of most polyatomic ions end in **-ite** or **-ate**.

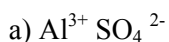
Exceptions:
ammonium (NH_4^+),
cyanide (CN^-), and
hydroxide (OH^-).

This table of polyatomic ions will be given on test

Naming Ternary Ionic Compounds: First, always recognize the polyatomic ion, then write cation first, anion last, names of cations and polyatomic ions remain the **same**, monoatomic anion change to ending -ide. Use roman numerals to indicate charge of cation if necessary (metals that can ... vary...).

Writing Formulas: Always view the polyatomic ion as one unit that must not be altered inside. Use parentheses if a polyatomic ion is more than once in the formula. Example: $Ca(NO_3)_2$ is calcium nitrate

Practice problems: Write the names and formulas of the ionic compounds made from the following ions:



Hydrates

A **hydrate** is a compound in which there is a specific ratio of water to ionic compound.

In a hydrate the water molecules are chemically bonded to the ionic compound.

A substance that absorbs water molecules from the air to become a hydrate is called **hygroscopic**.

To write the formula of a hydrate, first write the formula of the ionic compound and then place a dot followed by the number of water molecules per formula unit of that compound.

Example $CuSO_4 \cdot 2 H_2O$ with the name Copper (II)sulfate dihydrate. (mono, di, tri etc. see section 5.2)

For test: know terms hydrate and hygroscopic, but you don't have to name hydrates or write their formula

More practice problems

1) What is the charge of the cations and what is the name for each ionic compound?



2) What is the name for



Remember roman numerals are **not** necessary, in naming group 1A, 2A, and most of 3A metal ions

3) Pearls, seashells, marble and chalk are made from Ca^{2+} and carbonate CO_3^{2-} . Write correct formula and name:

4) Find the formula for iron (II) sulfate

◆ **Summary of Naming and writing formulas of ionic compounds**

metal(s) + nonmetal(s) ⇒ Ionic compound	
<p style="text-align: center;">2 elements ⇒ Binary ionic compound <i>example Mg and P</i></p> <p>Identify metal ⇒ cation (first) and nonmetal ⇒ anion (second)</p> <p><u>Find charges</u> from periodic table, except groups B and group IVA</p> <p style="text-align: center;">Mg^{2+} and P^{3-}</p> <p>Find Formula Criss-cross and adjust to smallest whole # ratio</p> <p style="text-align: center;">Mg_3P_2</p> <p>Find Name Cation keeps the element's name Anion changes ending to -ide</p> <p style="text-align: center;"><i>Magnesium phosphide</i></p> <p>Roman numerals only needed for group B and group IVA cations, represents charge of cation</p> <p style="text-align: center;">Fe^{3+} and P^{3-} FeP <i>Iron (III) phosphide</i></p> <p><i>More examples:</i> $\text{Na}^+ \text{N}^{3-} \rightarrow \text{Na}_3\text{N}$ sodium nitride $\text{Ti}^{4+} \text{O}^{2-} \rightarrow \text{TiO}_2$ titanium (IV) oxide</p>	<p style="text-align: center;">3 or more elements ⇒ Ternary ionic compound <i>example Mg, P and O</i></p> <p>Contains polyatomic ion Identify polyatomic ion (look up in table) Cation first anion second</p> <p><u>Find charges</u></p> <p style="text-align: center;">Mg^{2+} and PO_4^{3-}</p> <p>Find Formula Criss-cross (don't change polyatomic ion; put into parenthesis if more than one)</p> <p style="text-align: center;">$\text{Mg}_3(\text{PO}_4)_2$</p> <p>Find Name Polyatomic ion keeps its name (-ate, -ite) Monoatomic cation keeps its name (Monoatomic anion changes ending to -ide)</p> <p style="text-align: center;"><i>Magnesium phosphate</i></p> <p>Roman numerals?</p> <p style="text-align: center;">Fe^{3+} and PO_4^{3-} FePO_4</p> <p>Iron (III) phosphate</p> <p><i>More examples:</i> $\text{Sr}^{2+} \text{NO}_3^- \rightarrow \text{Sr}(\text{NO}_3)_2$ strontium nitrate $\text{Fe}^{3+} \text{SO}_4^{2-} \rightarrow \text{Fe}_2(\text{SO}_4)_3$ iron(III) sulfate</p>