Office Hours: M 1:30pm – 3:00pm
(in Park 169) W 11:00am – 12:00pm
or by appointment (email me)
or just email me with questions!

TA Hours w/ Dana: Th 6:00pm – 7:00pm
(in Park 273) F 4:30pm – 6:00pm

Q-center: https://www.brynmawr.edu/inside/offices-services/q-center/q-center-schedule

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Isotopes

Naming Compounds (Nomenclature Rules)

9/11/2026

Achieve HW #2 due Monday 9/14 at 10:00am
Achieve HW #3 due Thursday 9/17 at 8:00pm

Exam 1 in lecture a week from today! (everything through naming + simple mol calc)
Quiz #1 in Recitation today (9/11) – all material up through unit conversions

Chemistry ice cream social

Today @ 4pm in Park atrium courtyard

Learning Objectives

- Define isotopes and give examples for several elements

- Write and interpret symbols that depict the atomic number, mass number, and charge of an atom or ion
- Define the atomic mass unit and average atomic mass
- Calculate average atomic mass and isotopic abundance

- Define ionic and molecular (covalent) compounds
- Predict the type of compound formed from elements based on their location within the periodic table

- Determine formulas for simple ionic compounds
- Derive names for common types of inorganic compounds using a systematic approach

- Know the polyatomic ion names, charges, and formulas indicated in the table on slide 16, and how to use them in nomenclature

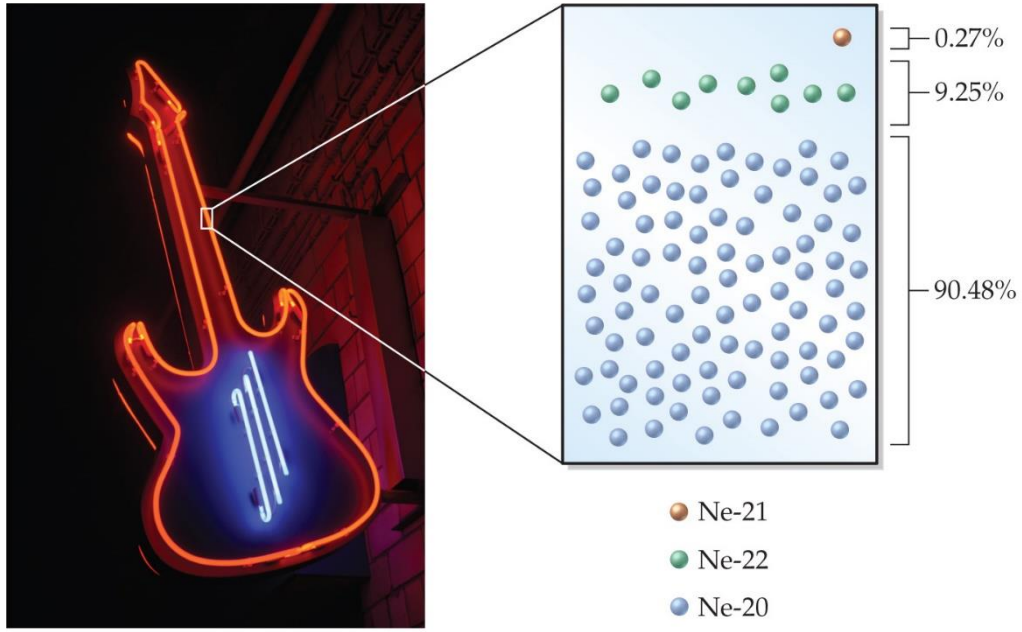
Isotopes: When the Number of Neutrons Varies

- All atoms of a given element have the same number of protons.
- They do not necessarily have the same number of neutrons.
- Atoms with the same number of protons but different numbers of neutrons are called **isotopes**.
- All elements have their own unique percent **natural abundance** of isotopes.

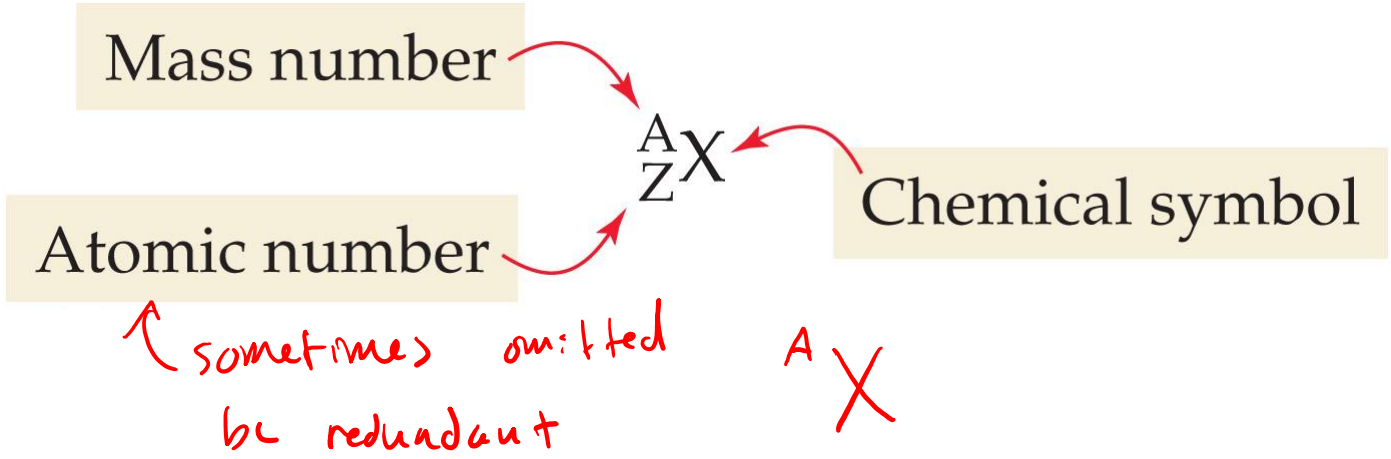
Isotopes: Natural Abundance of Isotopes in Neon

Naturally occurring neon contains three different isotopes:

	# protons	# neutrons	Mass Number (A)	Percent Abundance
Ne-20	10	10	20	90.48%
Ne-21	10	11	21	0.27%
Ne-22	10	12	22	9.25%



Isotope Symbol Notation



Isotopes of Neon: $^{20}_{10}Ne$ $^{21}_{10}Ne$ $^{22}_{10}Ne$ or ^{22}Ne

Mass number (A) = # protons + # neutrons

~1 amu ea. ~1 amu ea.

How many protons and neutrons are in this isotope of Uranium?

mass → $^{238}_{92}U$

92 protons

238 - 92 = 146 neutrons

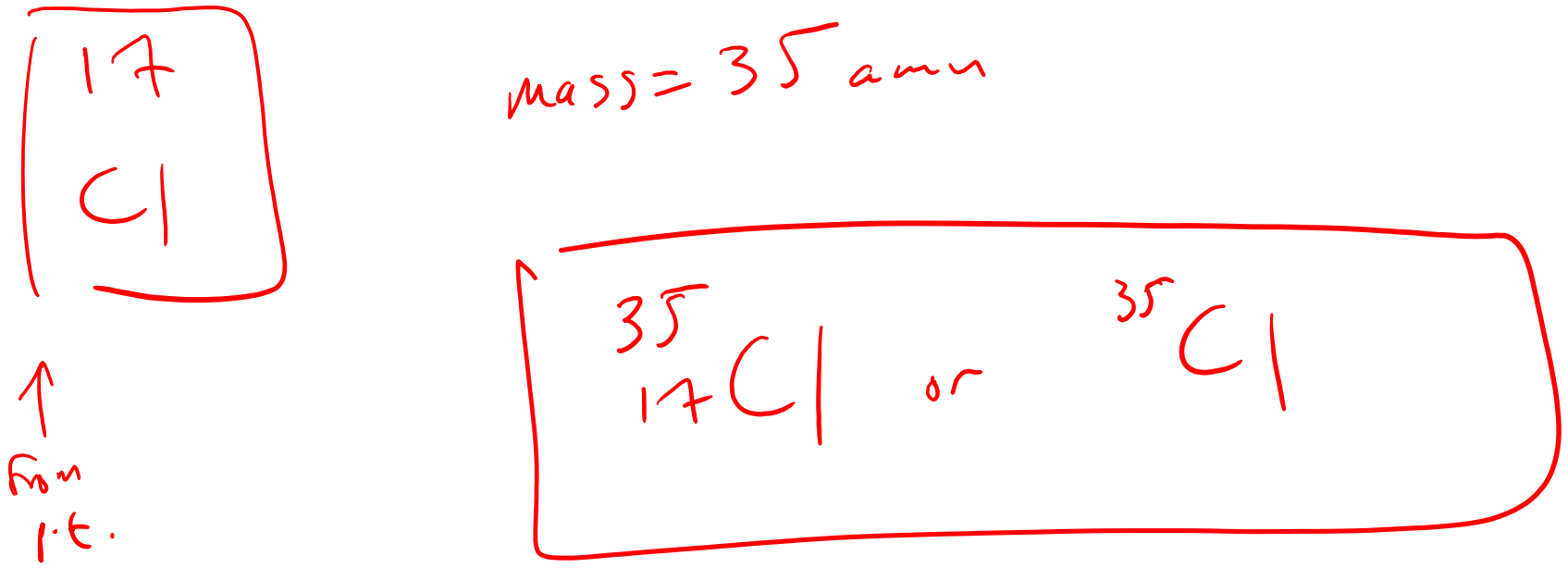
If an atom has a mass number of 32 and has 17 neutrons, it is an isotope of which element?

15 protons

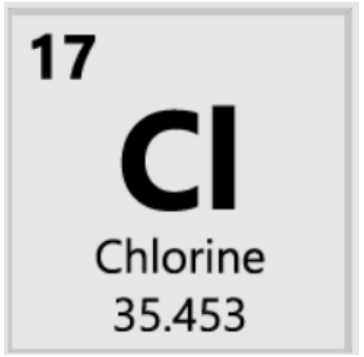
What is unique for each element? # protons

phosphorus

What are the atomic number, mass number, and symbols for the chlorine isotope with 18 neutrons?



Atomic Mass



Atomic mass: mass of element listed in periodic table

Atomic mass on periodic table is a weighted average

based on the natural abundance of each **isotope!**

	# protons	# neutrons	Mass Number (A)	Mass (amu)	Percent Abundance
Cl-35	17	18	35	34.97 amu	75.77%
Cl-37	17	20	37	36.97 amu	24.23%

Atomic mass = (75.77% x 34.97 amu) + (24.23% x 36.97 amu)

= (0.7577 x 34.97 amu) + (0.2423 x 36.97 amu) = 35.45 amu

Calculate the atomic mass of magnesium:

- isotope 1: 23.99 amu, 78.99% abundance
- isotope 2: 24.99 amu, 10.00% abundance
- isotope 3: 25.98 amu, 11.01% abundance

$(0.7899 \times 23.99\ \text{amu}) + (0.100 \times 24.99\ \text{amu}) + (0.1101 \times 25.98\ \text{amu})$

$= 24.31\ \text{amu}$

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could be given weighted average mass & mass & abundances of 2 out of 3 isotopes, & find mass & abundance of third.

Molecules & Compounds

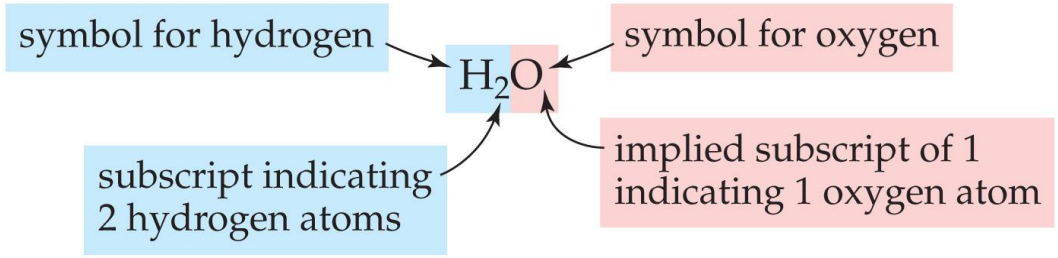
Molecule: two or more atoms held together by chemical bonds (ex: O_2, H_2O)

Compound: Pure substance consisting of two or more different elements combined in whole-number ratios (ex: H_2O)

Chemical Formulas

Indicate the ratio of each element in the compound

Ratio is always the same for a given compound



Example: H_2O

H = symbol for hydrogen; subscript 2 means 2 H atoms

O = symbol for oxygen; implied subscript 1 means 1 O atom

Table Sugar: $C_{12}H_{22}O_{11}$

12 C atoms, 22 H atoms, 11 O atoms in every molecule

Ratio 12:22:11

Chemical Formulas

- Metal elements are listed first (example NaCl, KBr)

- For nonmetals, list the most metallic element first (left-most in periodic table) (Example: CO_2, NO)

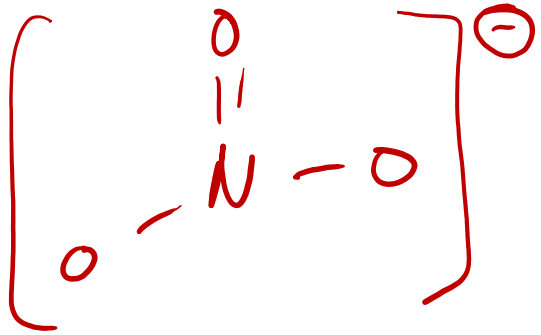
Example: Write a chemical formula for a compound containing two silver atoms for every sulfur atom.

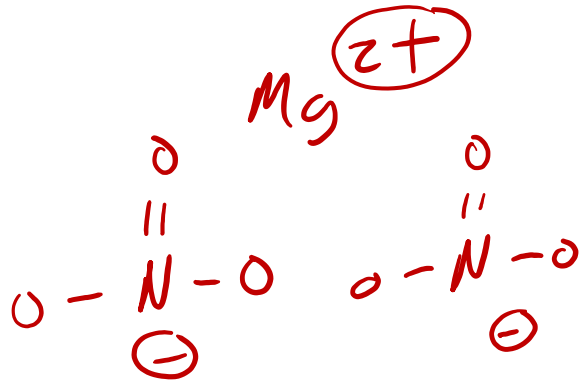
Ag_2S

Polyatomic Ions

Charged species (ion) made up of two or more atoms

Example: Nitrate ion = NO_3^-





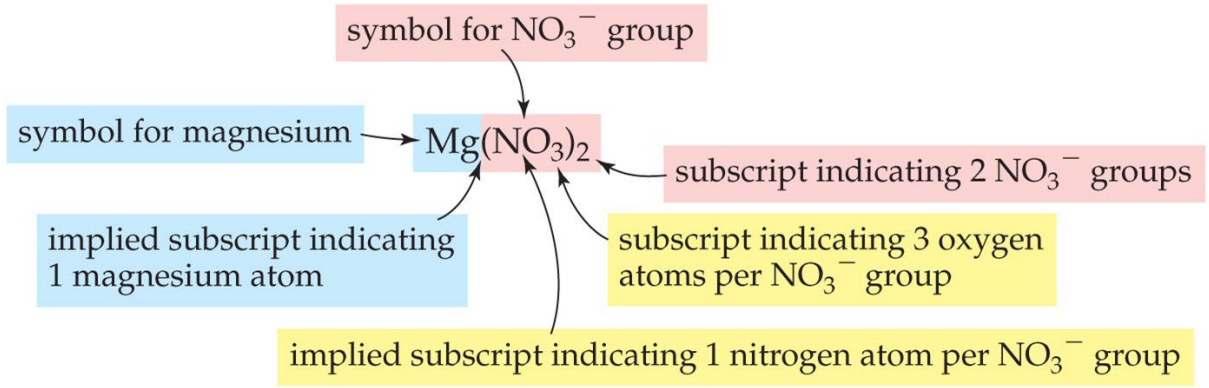
Magnesium Nitrate $Mg(NO_3)_2$

2 nitrate ions for every 1 magnesium

1 Mg and 2 NO_3^-

in total: 1 Mg, 2 N, 6 O

Polyatomic Ions



Memorize these names, formulas, and charges!

Flash cards!

Polyatomic Ion	Name	Polyatomic Ion	Name
NO_3^-	Nitrate	ClO_4^-	Perchlorate
NO_2^-	Nitrite	ClO_3^-	Chlorate
SO_4^{2-}	Sulfate	ClO_2^-	Chlorite
SO_3^{2-}	Sulfite	ClO^-	Hypochlorite
PO_4^{3-}	Phosphate	*Pattern above applies to other halogens as well (i.e. bromate, iodite)	
CO_3^{2-}	Carbonate	CN^-	Cyanide
HCO_3^-	Bicarbonate	OH^-	Hydroxide
$C_2H_3O_2^-$	Acetate	NH_4^+	Ammonium
MnO_4^-	Permanganate		

Example:

Determine the number of each type of atom in $Al_2(SO_4)_3$

2 Al

3 S

12 O

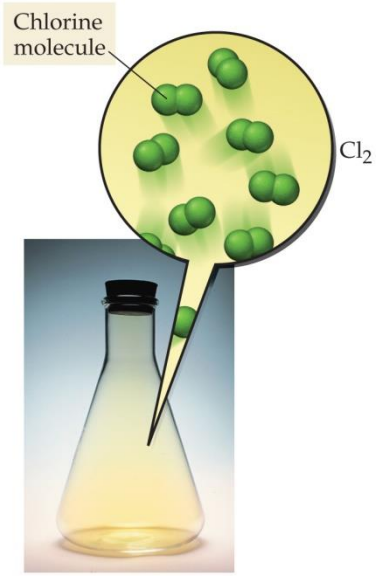
Elements and Compounds

Elements = cannot be simplified → only one type of atom in structure

Compounds = composed of two or more elements

Atomic Elements: Exist as single atoms; Most elements; Example: Helium, Copper, Carbon

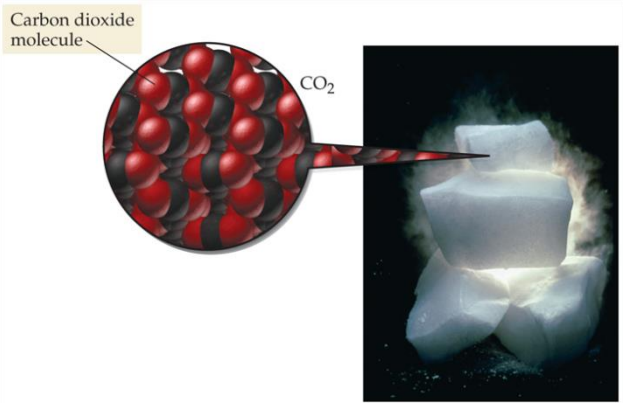
Molecular Elements ("Diatomic Elements"): Exist as two atoms bonded together; There are seven: H_2, O_2, N_2, Cl_2, F_2, I_2, Br_2 HONCLFIBr



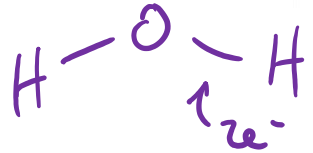
nonmetals only

Covalent Compounds (also called molecular compounds):

two or more nonmetals (example: H_2O, CO_2, many organic molecules are made of C H and O)



e^- pairs are shared between atoms to make "covalent" bonds.

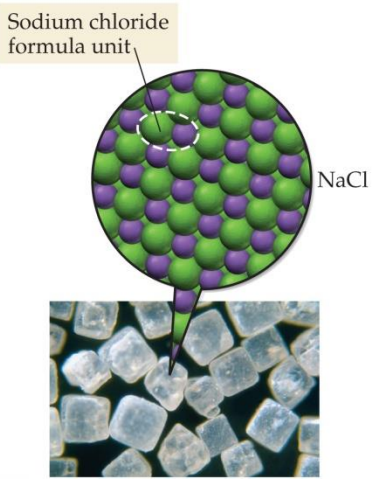


Ionic Compounds: formed from a metal and a nonmetal

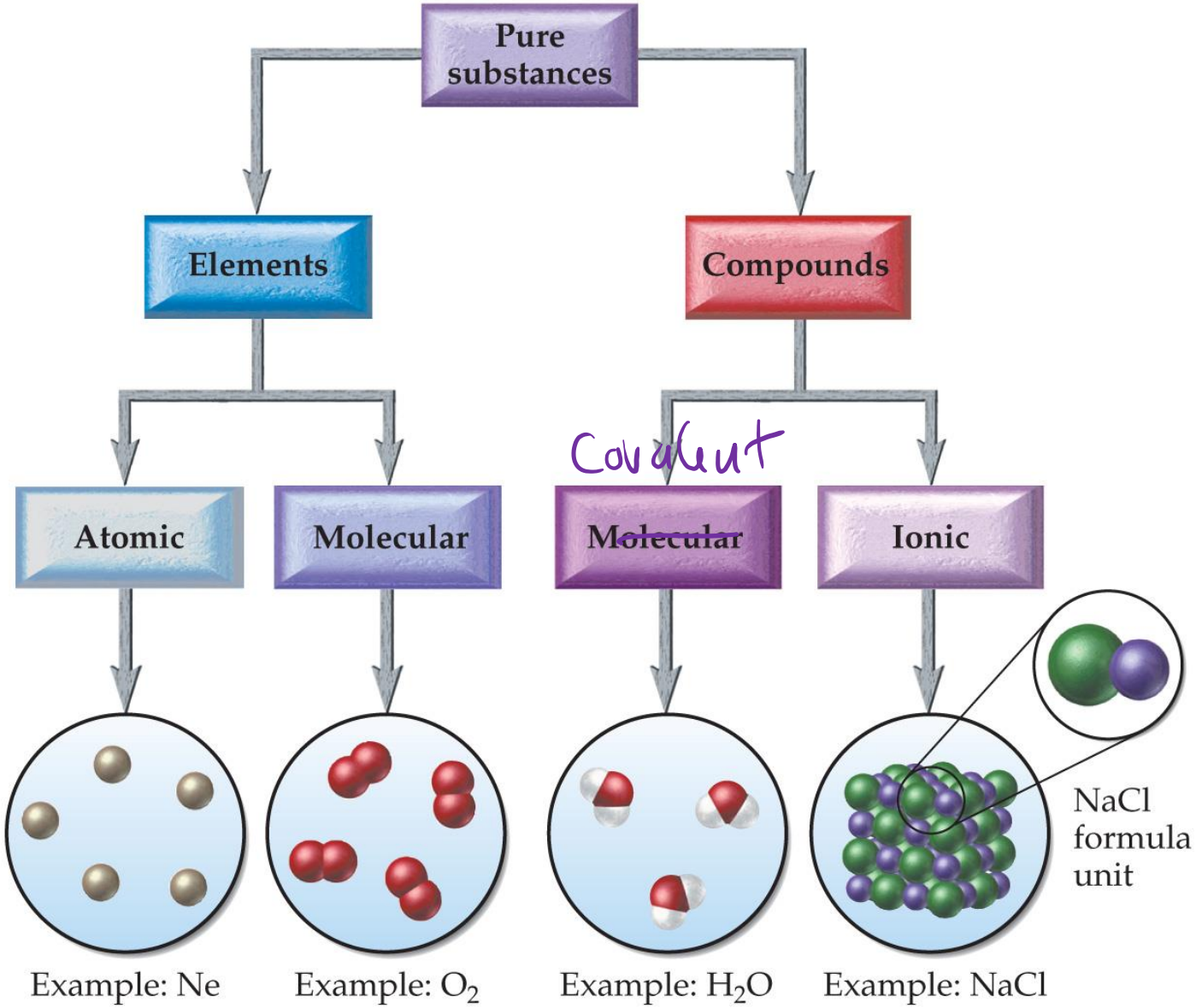
Not a real "bond" between ions: just + and − attraction.

- metals have positive charge (lose electrons), → relative to neutral atom on P.T.
- nonmetals have negative charge (gain electrons)

follow charge rules from pt.



Classification of Elements and Compounds



Practice: Classify each element (as atomic or diatomic/molecular) or compound (as covalent/molecular or ionic).

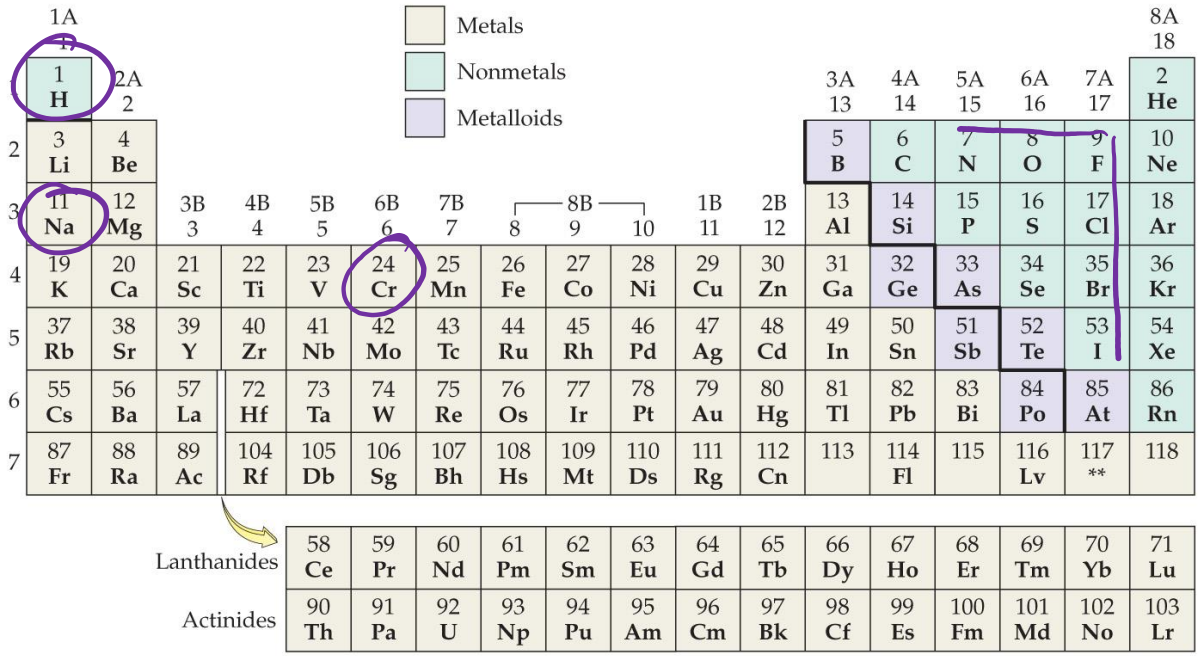
(a) Chlorine molecular

(b) NO covalent

(c) gold (Au) atomic

(d) Na_2O ionic

(e) $CrCl_3$ ionic



Writing Formulas for Ionic Compounds

Ionic compounds are neutral (charges cancel out)

total charge = 0

Formulas can be predicted based on periodic table (charge rules)

Example: Na_xCl_y

Na^+ Cl^- so $NaCl$

1 1

Neutral.

Mg and Cl

Mg^{2+} Cl^-

$MgCl_2$

Aluminum and Oxygen:

Al^{3+} O^{2-}

need least common multiple of charges.

Al_2O_3

Writing formula with polyatomic ions

- Ionic compounds often contain one or more polyatomic ions
  - Polyatomic ion: charged species (ion) made up of two or more atoms

Example: $Mg(NO_3)_2$

2 goes outside the parenthesis to indicate there are 2 NO_3^- ions.

K and CO_3^{2-}

K^+

K_2CO_3

Al and SO_4^{2-}

Al^{3+}

$Al_2(SO_4)_3$

Mg and O

$2+$ $2-$

MgO

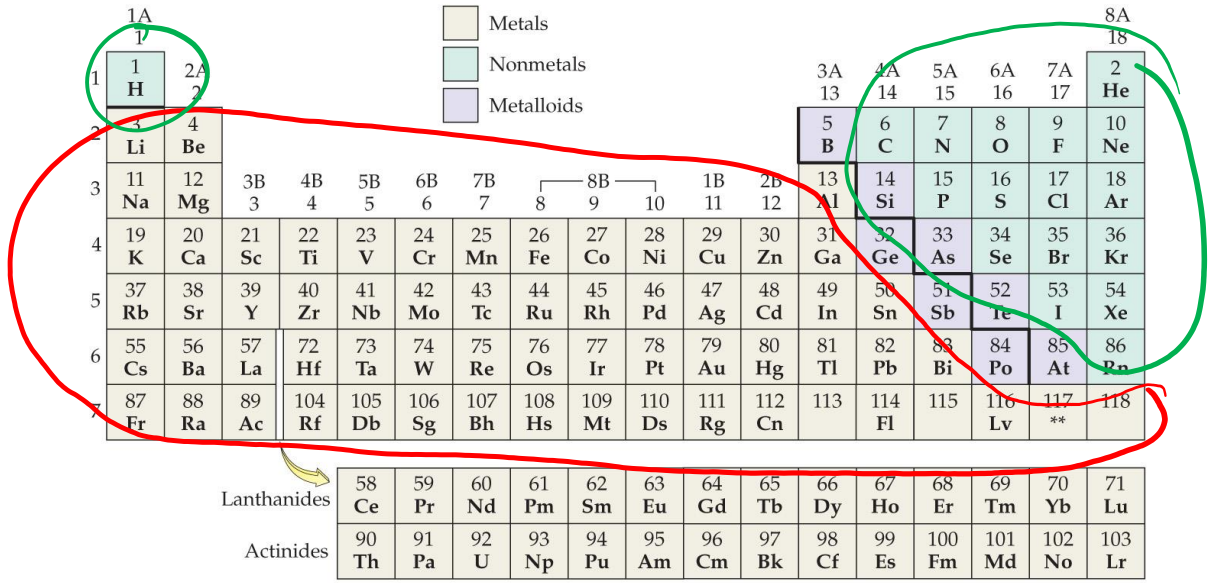
Na and hydroxide

Na^+ OH^-

$NaOH$

Nomenclature: Naming Ionic Compounds

- The first step in naming an ionic compound is **identifying** it as one.
  - If there is a **metal** and a **nonmetal** together in a chemical formula, the compound is ionic.
  - Covalent compounds (made of nonmetals only) use *different* naming rules.



Naming Cations in Ionic Compounds

Type 1 Metal: only forms one type of ion

ex: Na only forms 1+ ion (Na^+)

Group 1A, 2A, 3A

Zinc = Zn^{2+} and Silver = Ag^+

Type 2 Metal: can form more than one type of ion

ex: Fe forms Fe^{2+} and Fe^{3+}

Most transition metals form more than one type of ion

Type II Metal	Charges
Cr	2+, 3+
Fe	2+, 3+
Co	2+, 3+
Cu	1+, 2+
Sn	2+, 4+
Pb	2+, 4+
Hg_2^{2+} / Hg^{2+}	1+, 2+

For naming:

Type 1 cation - name is just name of element

ex: Na^+ = Sodium

Type 2 cation - name includes the charge as a roman numeral

ex: Fe^{2+} = iron (II)

Fe^{3+} = iron (III)

If the cation is a polyatomic ion, just use its name
ex. NH_4^+ = ammonium

Naming Anions in Ionic Compounds

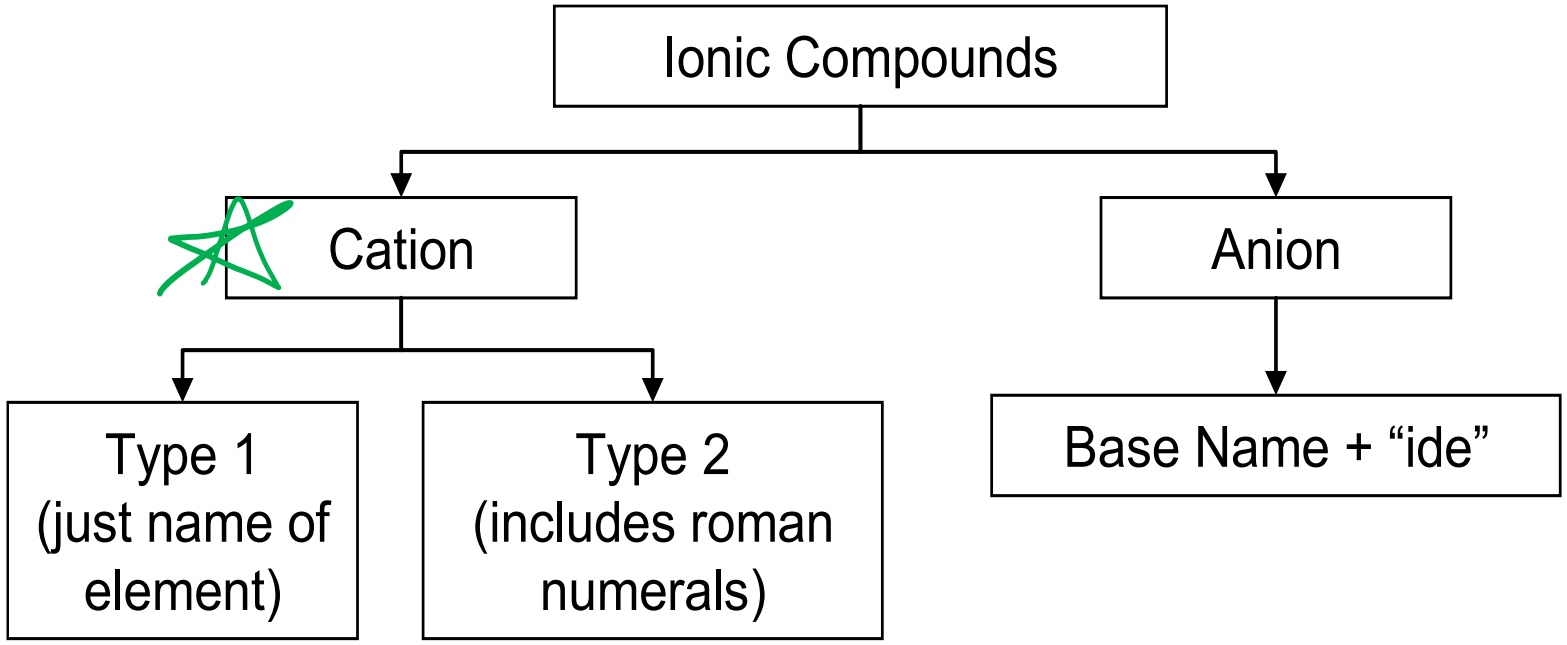
-ide means anion.

Drop ending of nonmetal's name and change it to –ide

Nonmetal	Symbol	Base Name	Anion Name
fluorine	F^-	fluor-	fluoride
chlorine	Cl^-	chlor-	chloride
bromine	Br^-	brom-	bromide
iodine	I^-	iod-	iodide
oxygen	O^{2-}	ox-	oxide
sulfur	S^{2-}	sulf-	sulfide
nitrogen	N^{3-}	nitr-	nitride

If the anion is a polyatomic ion, just use its name. OH^- hydroxide

Naming Ionic Compounds



If polyatomic ion, just use its name.

$NaCl$ sodium chloride

KBr potassium bromide

Zn_3N_2 zinc nitride

3+ 3-

$FeCl_3$ iron (III) chloride

$Cl^{\ominus}$

4+ 4-

$PbCl_4$ lead (IV) chloride

Cl^-

2+ 2-

PbO lead (II) oxide

$Cu(NO_2)_2$ copper (II) nitrite

$Fe(OH)_2$ iron (II) hydroxide

KNO_3 potassium nitrate

$NaClO$ sodium hypochlorite

$NaHCO_3$ sodium bicarbonate

Naming Molecular/Covalent Compounds

Molecular (covalent) compounds – two nonmetals

- Use prefixes

mono = 1	penta = 5
di = 2	hexa = 6
tri = 3	hepta = 7
tetra = 4	octa = 8

- Mono is omitted for the first element (but used for the second element)

CO_2 → carbon dioxide

prefix	name of 1st element	prefix	base name of 2nd element + *-ide*

CO → carbon monoxide

ionic compounds never have prefixes

covalent compounds only use prefix to indicate element's subscript

CO_2 carbon dioxide

CCl_4 carbon tetrachloride

NO nitrogen monoxide

SF_6 sulfur hexafluoride

N_2O dinitrogen monoxide

N_2O_4 dinitrogen tetroxide

- Achieve HW has very thorough practice with naming!

- Most difficult part? When given a mixture of ionic/covalent compounds….

  - **First** have to decide **which naming scheme to use???**

  - Does the compound have **nonmetals only**? (covalent compound)
    - Use prefixes (di, tri, tetra, etc)

  - Does the compound have a **metal** + a nonmetal? (ionic compound)
    - **No prefixes (di, tri, etc) in name**!
    - Is the metal in a column that follows charge rules?
      - If Yes – name is simple
      - If No – must find charge on metal and list as roman numeral!