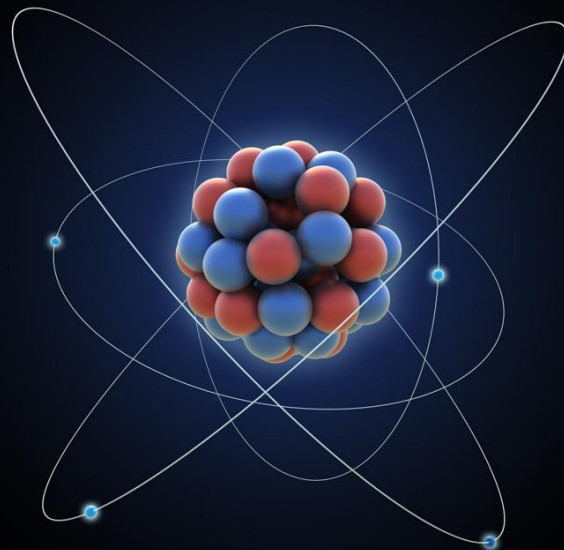




Chapter 2. Atoms, Molecules and Ions

General Chemistry I, CHEM 103-002

Lecture 4: Chemical Formula, Periodic Table, Ionic and Molecular Compounds

September 9th 2026

HW#1 due today at 5pm

How to study for CHEM103

- Read book and solve on your own book examples.
- Come and participate in lecture.
- At the end of each book chapter, there are additional exercises with an answer key provided at the end of the book.
- Go over lecture slides and solve lecture problems.
- Break up and do homework over multiple days.
- Ask yourself if you are comfortable in achieving the learning objectives outlined?
- Go to office hours with your questions. Email to arrange an appointment for office hours if you can't make a specific office hours.

Office Hours: Tuesday 9:15-10:15am
(in Park 22) Thursday 9:15-10:15am
or by appointment (email me)
or email me with questions!

TA Hours w/Ramona: Wednesday 2:00-4:00pm in **Park 252**

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

Announcements

- Class TA Office Hours with Ramona: Wednesday 2PM-4PM in Park 252.
- Plan for this week CHEM 103:
 - Complete Chapter 2
 - Homework 2: Will be posted tomorrow (9/10) at 9am and due Wednesday (9/16) 5pm.
 - Recitation Worksheet #2 for Friday recitation
- Recitation Period:
 - Lowest score of all recitation worksheets will be dropped
 - First 20 minutes we will spend solving altogether one problem.
 - Last 20-30 minutes spend on completing on your own recitation worksheet with closed book. Bring calculator. Need to submit worksheet at the end of recitation period.

Learning Objectives for Chapter Units 2.3 – 2.6

- Calculate atomic weights of elements when given isotope distribution or mass spectrometry data. Solve problems involving isotope distribution and atomic masses.
- Write and interpret symbols that depict the atomic number, mass number, and charge of an atom or ion.
- Calculate average atomic mass and isotopic abundance.
- Explain the organization of elements in the periodic table.
- Understand the structure of the periodic table; be able to rapidly find relevant information in it. Use it confidently to 1) classify elements as metals, nonmetals or metalloids (semimetals) and 2) identify if an element belongs to a key group/region discussed in class (alkali metals, transition metals, halogens, noble gases...).
- Know that matter can be made up of single atoms (elements), molecules (elements and compounds) or networks/extended structures (elements and compounds).
- Name and write formulas of the seven diatomic elements.
- Use the periodic table to predict charges of ions from key groups (e.g., alkali metals).
- Name and write formulas of common monoatomic ions.
- 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.

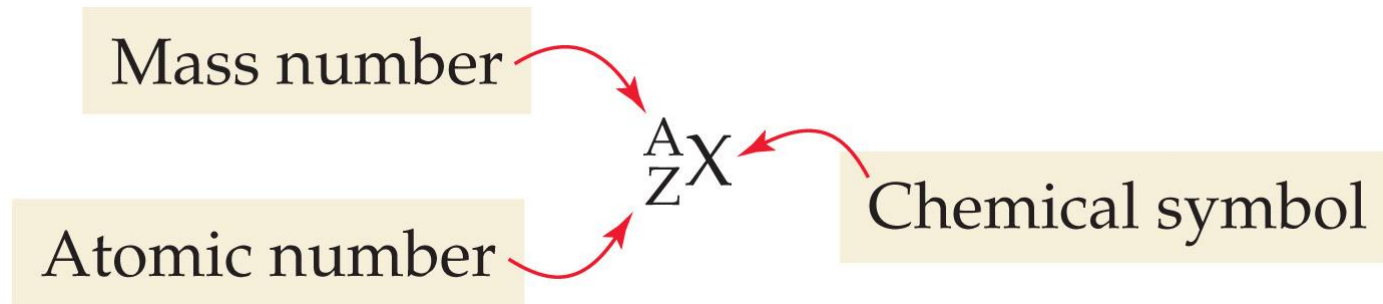
Chapter Unit 2.3

Atomic Structure, Symbolism and Isotopes

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.

Isotope Symbol Notation



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

Mass number (A) = # protons + # neutrons

$$A = Z + \text{\# neutrons}$$

Participation Questions

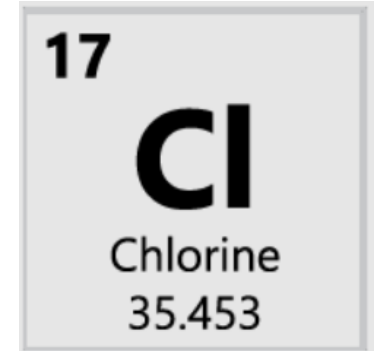
1. How many protons and neutrons are in this isotope of Uranium? $^{238}_{92}\text{U}$
2. If an atom has a mass number of 32 and has 17 neutrons, it is an isotope of which element?
3. What is unique for each element?
4. What are the atomic number, mass number, and symbols for the chlorine isotope with 18 neutrons?

<https://docs.google.com/forms/d/e/1FAIpQLSfxgeXLY0WCnx2nsFg0-XBYdBVzkUOLEzNL0Efjvov509VPyQ/viewform?usp=publish-editor>

Atomic Mass

Atomic mass: mass of element listed in periodic table

Atomic mass on periodic table is a _____
based on the natural abundance of each **isotope!**

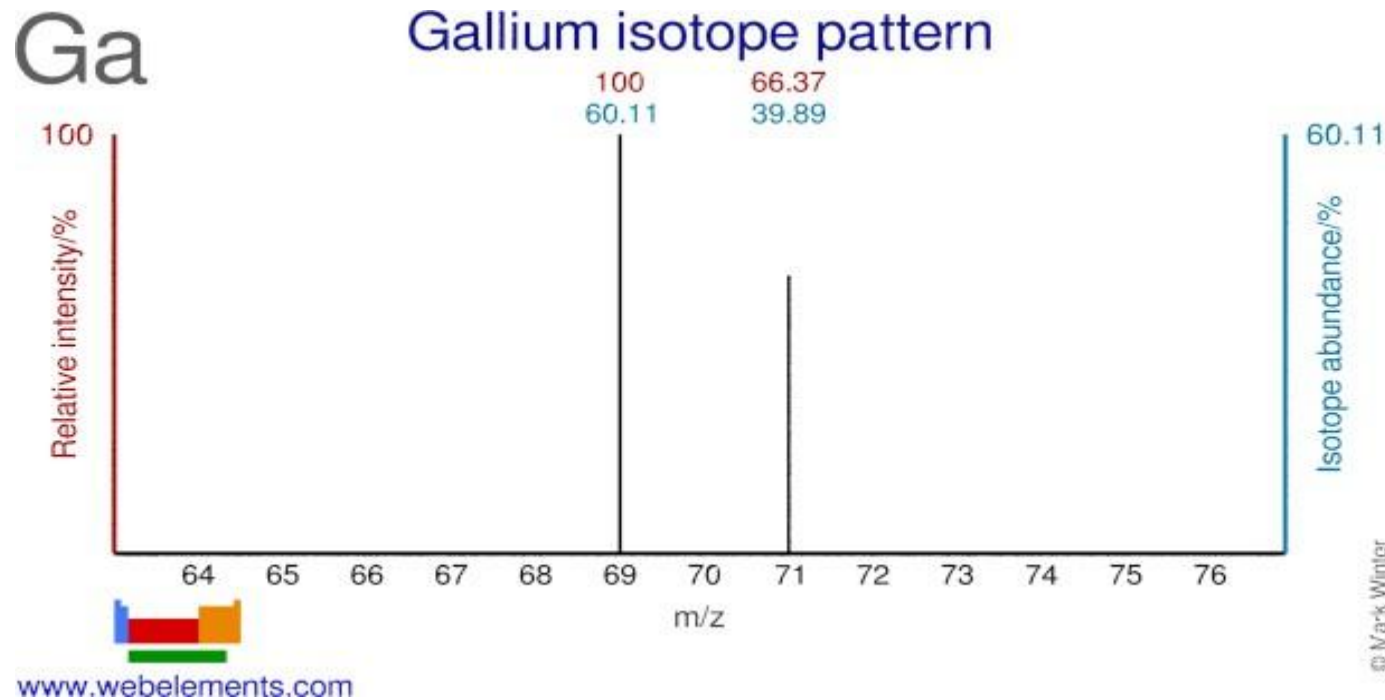


	# protons	# neutrons	Mass Number (A)	Mass (amu)	Percent Abundance
Cl-35	17	18	35	34.45 amu	75.77%
Cl-37	17	20	37	36.97 amu	24.23%

$$\text{Atomic mass} = (75.77\% \times 34.45 \text{ amu}) + (24.23\% \times 36.97 \text{ amu})$$

$$= (0.7577 \times 34.45 \text{ amu}) + (0.2423 \times 36.97 \text{ amu}) = 35.45 \text{ amu}$$

Example element mass spectrum: gallium (Ga)



1. What stable isotopes of Gallium can we derive from the given mass spectrum?
2. State what are the number of protons, electrons, and neutrons in each of them.

<https://docs.google.com/forms/d/e/1FAIpQLScLi3-NmHHyGEOXQc8Ya6HW6YAWMJV-TtLnOdKg87iNscSaw/viewform?usp=header>

Practice problem

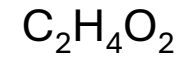
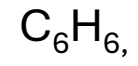
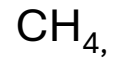
What are the percent natural abundances of the two naturally occurring isotopes of boron, ^{10}B and ^{11}B ? These isotopes have masses of 10.012937 u and 11.009305 u, respectively.

Chapter Unit 2.4

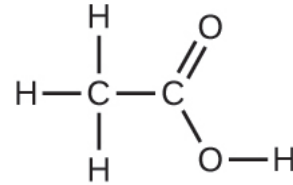
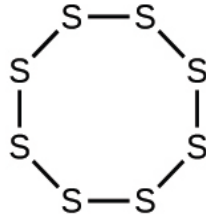
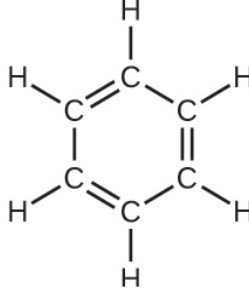
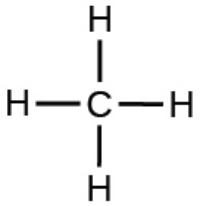
Chemical Formula

Chemical Formula

- Molecular Formula



- Structural Formula



- Empirical Formula

Chemical Formula

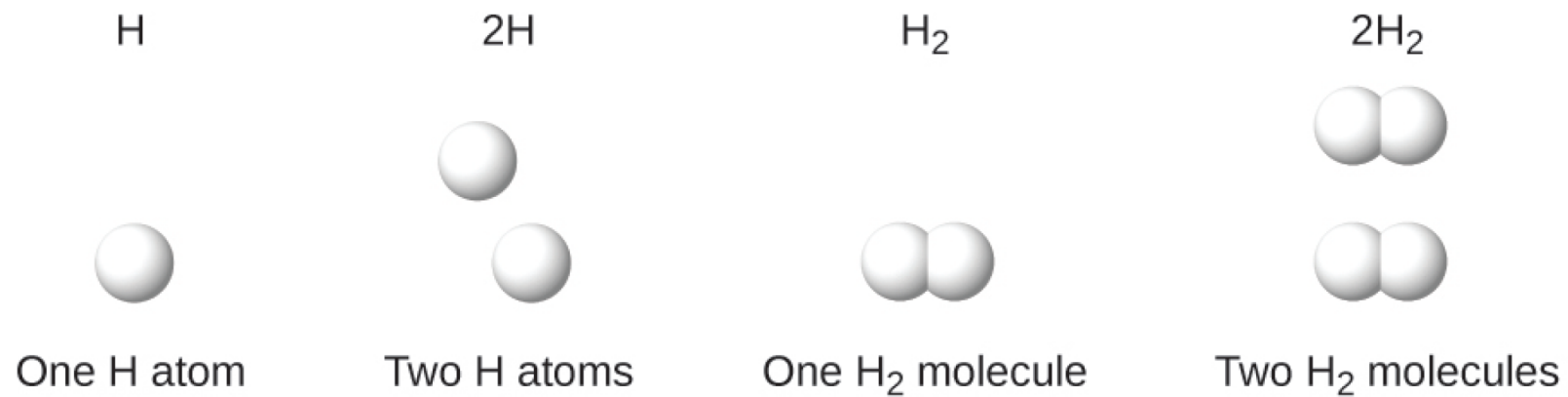
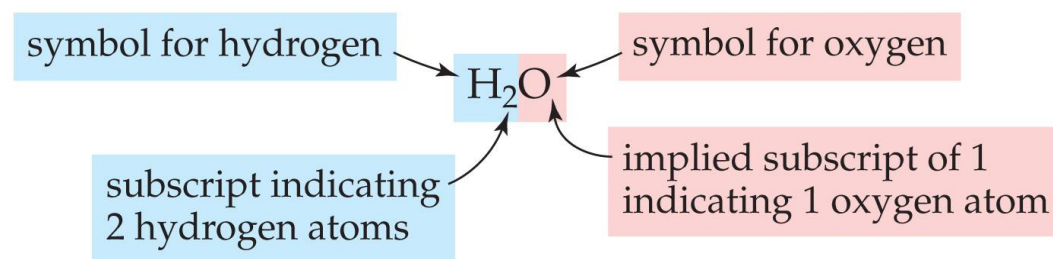


FIGURE 2.18 The symbols H, 2H, H₂, and 2H₂ represent very different entities.

Chemical/Molecular Formula

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: $\text{C}_{12}\text{H}_{22}\text{O}_{11}$

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

Ratio 12:22:11

Chapter Unit 2.5

The Periodic Table

Periodic Table

Organized by Dmitri Mendeleev (1869)

When elements are arranged in order of increasing mass, certain sets of properties recur periodically. Left spaces for then undiscovered elements; predicted their properties

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
H	He	Li	Be	B	C	N	O	F	Ne	Na	Mg	Al	Si	P	S	Cl	Ar	K	Ca

Arranged elements in rows so vertical columns share similar properties.

1 H							2 He
3 Li	4 Be	5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg	13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca						

Periodic Law: It's all about the protons and electrons (electron configuration)

The **periodic law**, is as follows: the properties of the elements are periodic functions of their atomic numbers.



Protons: Identity

- Defines the Element
- Sets the Sequence
- Anchors the Electrons

Electrons: Periodicity

- Drives Chemical Reactions
- Creates the "Periodicity"



If protons are the foundation and address of a house, electrons are the architecture and the people living inside—they determine what the house actually looks like and how it interacts with the neighborhood.

Locating Metals, Nonmetals, Metalloids

1A 1																		8A 18	
1	1 H	2A 2																	2 He
2	3 Li	4 Be																	10 Ne
3	11 Na	12 Mg	3B 3	4B 4	5B 5	6B 6	7B 7	8B 8 9 10		1B 11	2B 12	13 Al	14 Si	15 P	16 S	17 Cl	18 Ar		
4	19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr	
5	37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe	
6	55 Cs	56 Ba	57 La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn	
7	87 Fr	88 Ra	89 Ac	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113	114 Fl	115	116 Lv	117 **	118	

Lanthanides

Actinides

58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

Metals

Electrical - Conductive

Thermal - Conductive

Metallic gray luster

Most are solids**

Malleable - sheets

Ductile – wires

Tend to form (+) ions

Nonmetals

Electrical - Insulator

Thermal - Insulator

No luster

All phases

Brittle

Nonductile

Tend to form (-) ions, but
(+) ions are not uncommon.

Locating Main Families of the Periodic Table

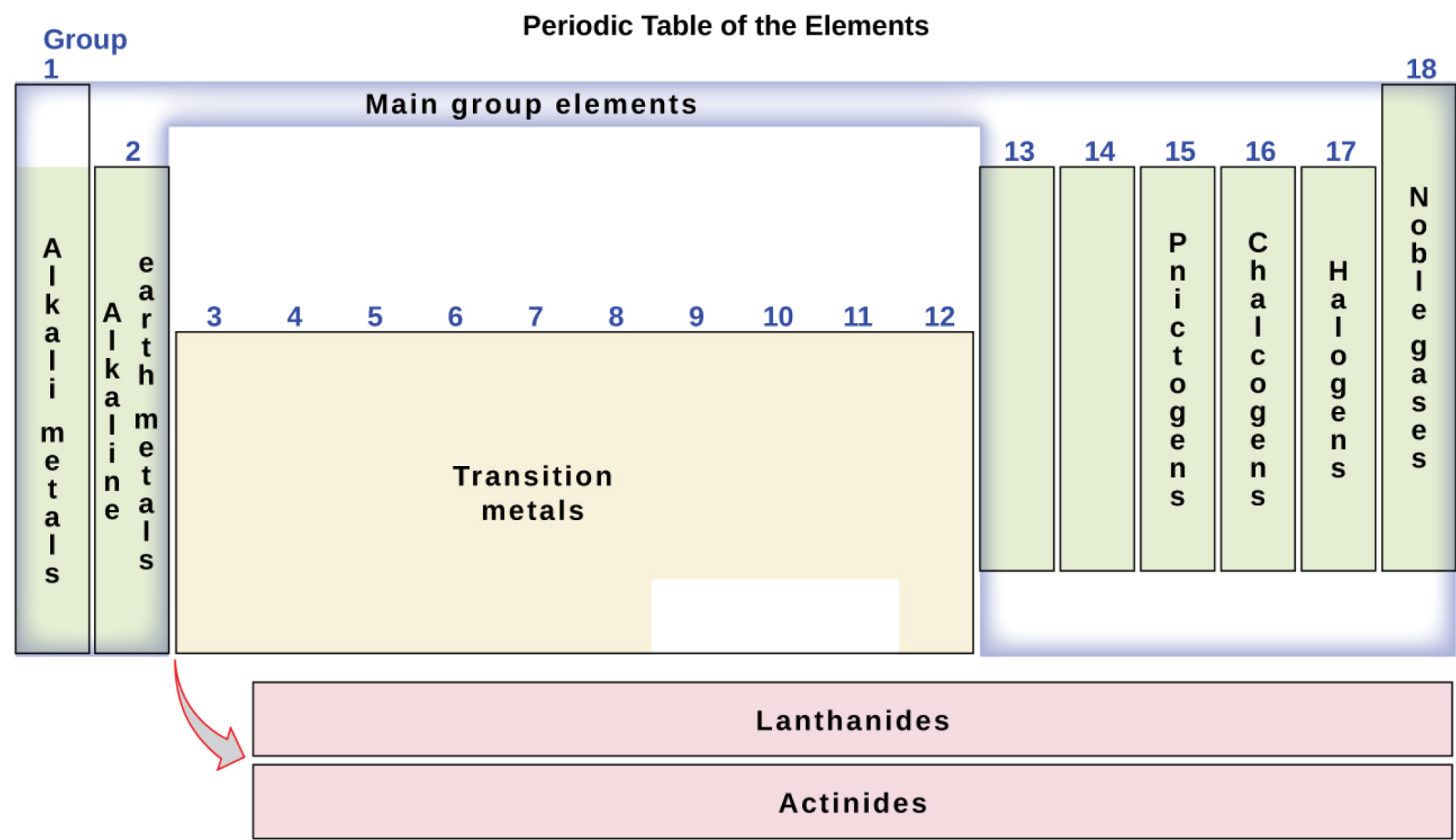


FIGURE 2.27 The periodic table organizes elements with similar properties into groups.

Main Group Elements and Transition Elements

Main-group elements		Transition elements										Main-group elements					
1A 2A												3A 4A 5A 6A 7A 8A					
1 H	2 He											3 B	4 C	5 N	6 O	7 F	8 Ne
3 Li	4 Be											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
11 Na	12 Mg	3B	4B	5B	6B	7B	8B		1B	2B							
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	57 La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
87 Fr	88 Ra	89 Ac	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Nh	114 Fl	115 Mc	116 Lv	117 Ts	118 Og

For main group elements, **properties** can generally be predicted based on the **element's position**.

Groups 1A Alkali Metals

- When burned in air, alkali metals form either the oxide, peroxide, or superoxide as the principal product, depending on the size of the cation.

$M + O_2 \rightarrow$	Li_2O	Na_2O_2	KO_2	RbO_2	CsO_2
Anion	oxide	peroxide	superoxide	superoxide	superoxide

Alkali metals
↓
1A

Alkaline earth metals
↓
2A

1 H	4 Be				
3 Li	12 Mg				
11 Na	19 K	20 Ca	21 Sc	22 Ti	23 V
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo
55 Cs	56 Ba	57 La	72 Hf	73 Ta	74 W
87 Fr	88 Ra	89 Ac	104 Rf	105 Db	106 Sg

Lanthanides

Actinides

58 Ce	59 Pr
90 Th	91 Pa

Alkali metals

Li
Na
K
Rb
Cs



Noble gases
↓
8A

Halogens
↓
7A

6A	7A	8A
8 O	9 F	10 Ne
16 S	17 Cl	18 Ar
34 Se	35 Br	36 Kr
52 Te	53 I	54 Xe
84 Po	85 At	86 Rn
116 Lv	117 **	118

69 Tm	70 Yb	71 Lu
101 Md	102 No	103 Lr

Groups 2A Alkaline Earth

Alkali metals

Alkaline earth metals

Alkaline earth metals

Group numbers

Noble gases

Halogens

1A 2A 3A 4A 5A 6A 7A 8A

1 H 2 He

3 Li 4 Be 5 B 6 C 7 N 8 O 9 F 10 Ne

11 Na 12 Mg 13 Al 14 Si 15 P 16 S 17 Cl 18 Ar

19 K 20 Ca 21 Sc 22 Ti 23 V 24 Cr 25 Mn 26 Fe 27 Co 28 Ni 29 Cu 30 Zn 31 Ga 32 Ge 33 As 34 Se 35 Br 36 Kr

37 Rb 38 Sr 39 Y 40 Zr 41 Nb 42 Mo 43 Tc 44 Ru 45 Rh 46 Pd 47 Ag 48 Cd 49 In 50 Sn 51 Sb 52 Te 53 I 54 Xe

55 Cs 56 Ba 57 La 72 Hf 73 Ta 74 W 75 Re 76 Os 77 Ir 78 Pt 79 Au 80 Hg 81 Tl 82 Pb 83 Bi 84 Po 85 At 86 Rn

87 Fr 88 Ra 89 Ac 104 Rf 105 Db 106 Sg 107 Bh 108 Hs 109 Mt 110 Ds 111 Rg 112 Uut 113 Uuq 114 Uub 115 Uut 116 Uuq 117 ** 118

Lanthanides

Actinides

58 Ce 59 Pr 60 Nd 61 Pm 62 Sm 63 Eu 64 Gd 65 Tb 66 Dy 67 Ho 68 Er 69 Tm 70 Yb 71 Lu

90 Th 91 Pa 92 U 93 Np 94 Pu 95 Am 96 Cm 97 Bk 98 Cf 99 Es 100 Fm 101 Md 102 No 103 Lr

Be

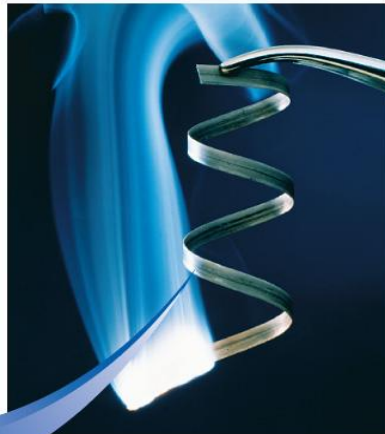
Mg

Ca

Sr

Ba

Alkaline earth metals



Groups 5A Pnictogen

Alkali metals ↓ 1A		Alkaline earth metals ↓ 2A			
1 H		4 Be			
3 Li		12 Mg			
11 Na					
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo
55 Cs	56 Ba	57 La	72 Hf	73 Ta	74 W
87 Fr	88 Ra	89 Ac	104 Rf	105 Db	106 Sg
		Lanthanides ↓			
		58 Ce	59 Pr		
		90 Th	91 Pa		
		Actinides			

Pnictogens (Group 15)




N
P
As
Sb
Bi

				Noble gases ↓ 8A	
Group numbers				2	
5A	6A	7A		He	
7 N	8 O	9 F		10 Ne	
15 P	16 S	17 Cl		18 Ar	
33 As	34 Se	35 Br		36 Kr	
51 Sb	52 Te	53 I		54 Xe	
83 Bi	84 Po	85 At		86 Rn	
115	116 Lv	117 **		118	
68 Er	69 Tm	70 Yb	71 Lu		
100 Fm	101 Md	102 No	103 Lr		

The group 15 elements, known as pnictogens (from Greek *pnigēin*, meaning "to choke"). This refers to the asphyxiating properties of pure nitrogen gas, which is the first element in the group, and to the poisonous, choking nature of some compounds formed by other elements in the group, such as arsenic.

Groups 6A Chalcogen

Alkali metals ↓ 1A		Alkaline earth metals ↓ 2A							
1 H		4 Be							
3 Li		12 Mg							
11 Na				21 Sc	22 Ti	23 V			
19 K	20 Ca								
37 Rb	38 Sr	39 Y	40 Zr	41 Nb					
55 Cs	56 Ba	57 La	72 Hf	73 Ta					
87 Fr	88 Ra	89 Ac	104 Rf	105 Db					
				Lanthanides ↓ Actinides					
				58 Ce					
				90 Th					

Chalcogens (Group 16)

O
S
Se
Te
Po



					Noble gases ↓ 8A	
Group numbers					2	He
6A	5A	6A	7A		10	Ne
6 C	7 N	8 O	9 F		18 Ar	
14 Si	15 P	16 S	17 Cl			
32 Ge	33 As	34 Se	35 Br	36 Kr		
50 Sn	51 Sb	52 Te	53 I	54 Xe		
82 Pb	83 Bi	84 Po	85 At	86 Rn		
114 Fl	115	116 Lv	117 **	118		
67 Ho	68 Er	69 Tm	70 Yb	71 Lu		
99 Es	100 Fm	101 Md	102 No	103 Lr		

The Group 16 elements are named chalcogen from the Greek, meaning "ore-forming," as these elements readily combine with metals to form ores in nature.



CuFeS_2
Chalcopyrite
"Fool's gold"

Groups 7A Halogens

Alkali metals

Alkaline earth metals

1A	2A	Transi					
1 H							
3 Li	4 Be						
11 Na	12 Mg						
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	
55 Cs	56 Ba	57 La	72 Hf	73 Ta	74 W	75 Re	
87 Fr	88 Ra	89 Ac	104 Rf	105 Db	106 Sg	107 Bh	

Lanthanides

Actinides

58 Ce	59 Pr	60 Nd
90 Th	91 Pa	92 U

Halogens

F
Cl
Br
I
At

Noble gases

Halogens

5A	6A	7A	8A
7 N	8 O	9 F	10 Ne
15 P	16 S	17 Cl	18 Ar
33 As	34 Se	35 Br	36 Kr
51 Sb	52 Te	53 I	54 Xe
83 Bi	84 Po	85 At	86 Rn
115	116 Lv	117 **	118

68 Er	69 Tm	70 Yb	71 Lu
100 Fm	101 Md	102 No	103 Lr



The word "halogen" means "salt former" or "salt maker". When halogens react with metals, they produce a wide range of salts.

Groups 8A Noble Gases

Alkali metals		Alkaline earth metals												Noble gases	
1A		2A												6A	8A
1 H														8 O	2 He
3 Li		4 Be												9 F	10 Ne
11 Na		12 Mg												16 S	18 Ar
19 K		20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn		34 Se	36 Kr
37 Rb		38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd		52 Te	54 Xe
55 Cs		56 Ba	57 La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg		84 Po	86 Rn
87 Fr		88 Ra	89 Ac	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn		116 Lv	118 Og
				Lanthanides										69 Tm	71 Lu
				Actinides										101 Md	103 Lr
				58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy		70 Yb	72 Hf
				90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf		102 No	104 Rf

Practice Exercise

1. Atoms of each of the following elements are essential for life. Give the group name for the following elements:

- Calcium
- Chlorine
- Sodium
- Sulfur

2. Give the group name for each of the following elements:

- Krypton
- Selenium
- Barium
- Lithium

		Group number																				8A
1A	↓																					2
1	H	2A											3A	4A	5A	6A	7A	He				
2	3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne				
3	11 Na	12 Mg	3B	4B	5B	6B	7B	8B				1B	2B	13 Al	14 Si	15 P	16 S	17 Cl	18 Ar			
4	19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr				
5	37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe				
6	55 Cs	56 Ba	57 La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn				
7	87 Fr	88 Ra	89 Ac	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113	114 Fl	115	116 Lv	117 **	118				

Chapter Unit 2.6

Ionic and Molecular Compounds

Atom

Protons, neutron and electrons

Protons = # Electrons

Atoms are _____ particles

Ion

Protons, neutron and electrons

Protons $\neq$ # Electrons

Ions are _____ particles

Cations vs Anions

Cation – positively charged particle (atom has lost one or more electrons)

Ex: $\text{Li} \rightarrow \text{Li}^+ + 1\text{e}^-$ Lithium ion charge = 1+

Anion – negatively charged particle (atom has gained one or more electrons)

Ex: $\text{F} + 1\text{e}^- \rightarrow \text{F}^-$ Fluorine ion charge = 1-

Ion Charge = # protons - # electrons

Valence Electrons

Valence electrons: located in the outer most shell of an atom.

have the highest energy of all electrons in an atom.

responsible for the **reactivity** and other properties of an atom.

Main Group Elements have same **number of valence electrons** as their **group number (column)**

Li has 1 valence e^- , Be has 2 valence e^- , B has 3 valence e^- , ...

[illegible]

Ions & Periodic Table

Main group elements tend to form ions that have the same number of **valence electrons** as the nearest noble gas.

- Li tends to lose 1 electron (become Li^+) to become like He
- Be tends to lose 2 electrons (become Mg^{2+}) to become like He
- F tends to gain 1 electron (become F^-) to become like Ne
- O tends to gain 2 electrons (become O^{2-}) to become like Ne

Group number

	1A	2A											3A	4A	5A	6A	7A	8A	
1	1 H																	2 He	
2	3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne	
3	11 Na	12 Mg	3B	4B	5B	6B	7B	8B				1B	2B	13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
4	19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr	
5	37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe	
6	55 Cs	56 Ba	57 La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn	
7	87 Fr	88 Ra	89 Ac	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113	114 Fl	115	116 Lv	117 **	118	

Ions and the Periodic Table



*This is a very important
slide to study!!!*

1A	2A											3A	4A	5A	6A	7A	8A
Li ⁺	Be ²⁺													N ³⁻	O ²⁻	F ⁻	
Na ⁺	Mg ²⁺											Al ³⁺			S ²⁻	Cl ⁻	
K ⁺	Ca ²⁺											Ga ³⁺			Se ²⁻	Br ⁻	
Rb ⁺	Sr ²⁺											In ³⁺			Te ²⁻	I ⁻	
Cs ⁺	Ba ²⁺																

Transition metals form cations
with various charges

Ions and the Periodic Table: Practice Exercise

(a) How many protons does potassium (K) have?

(b) What type of ion will K normally form?

(c) Write a reaction showing a K atom forming this ion.

(d) What group/family does K belong to?

(e) Determine the charge of a magnesium ion with 10 electrons

Group number		8A
1A	2A	
1 H	2 He	
3 Li	4 Be	10 Ne
11 Na	12 Mg	18 Ar
19 K	20 Ca	36 Kr
37 Rb	38 Sr	54 Xe
55 Cs	56 Ba	86 Rn
87 Fr	88 Ra	118

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)

Locating Metals, Nonmetals, Metalloids

1A 1																	8A 18
1 H	2A 2											3A 13	4A 14	5A 15	6A 16	7A 17	2 He
2 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
3 Na	12 Mg	3B 3	4B 4	5B 5	6B 6	7B 7	8B 8 9 10			1B 11	2B 12	13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
4 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
5 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
6 Cs	56 Ba	57 La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
7 Fr	88 Ra	89 Ac	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113	114 Fl	115	116 Lv	117 **	118

Lanthanides

58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

Chemical Formulas of Compounds

- Metal elements are listed first (example NaCl, KBr)
- For nonmetals, list the most metallic element first (left-most in periodic table)
(Example: CO₂, NO)

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

Polyatomic Ions

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

Example: Nitrate ion = NO_3^-

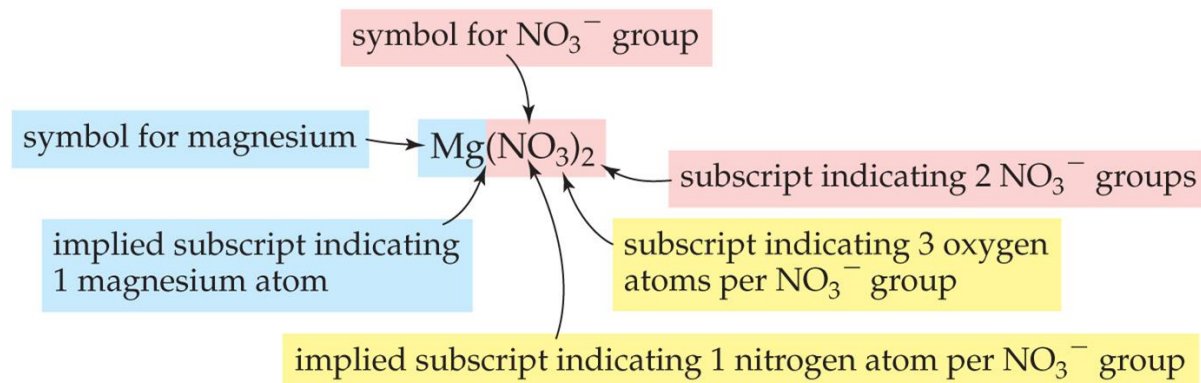
Magnesium Nitrate $\text{Mg}(\text{NO}_3)_2$

___ nitrate ions for every ___ magnesium

___ Mg and ___ NO_3^-

in total: ___ Mg, ___ N, ___ 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
$\text{C}_2\text{H}_3\text{O}_2^-$	Acetate	MnO_4^-	Permanganate
PO_4^{3-}	Phosphate	NH_4^+	Ammonium

Example:

Determine the number of each type of atom in $\text{Al}_2(\text{SO}_4)_3$

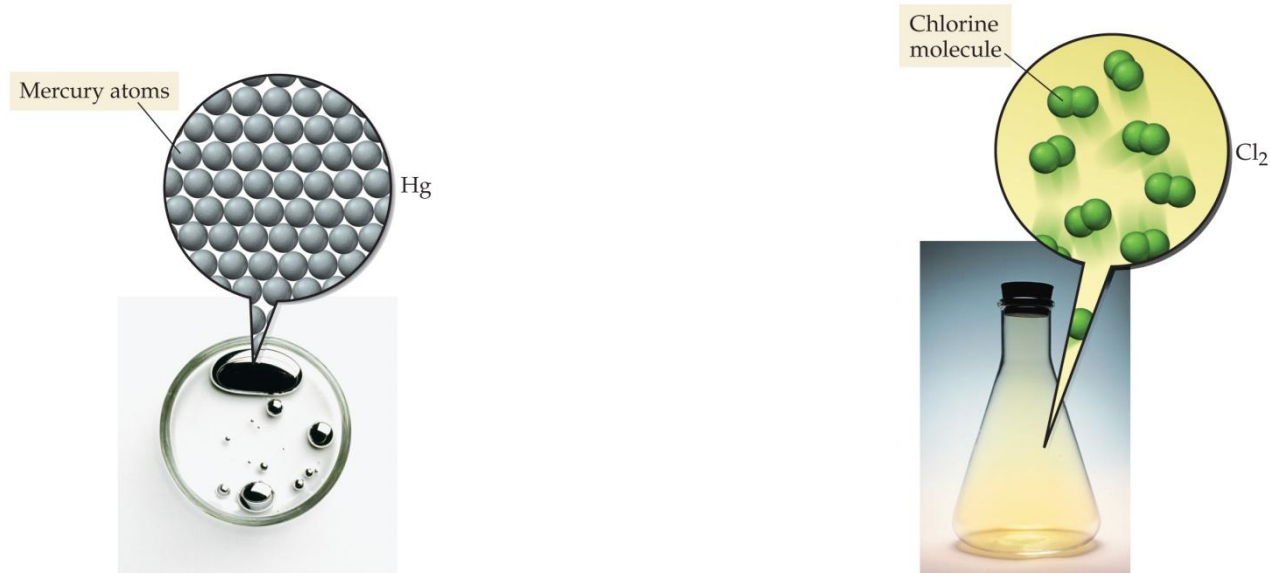
Elements and Compounds

Elements = cannot be simplified

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



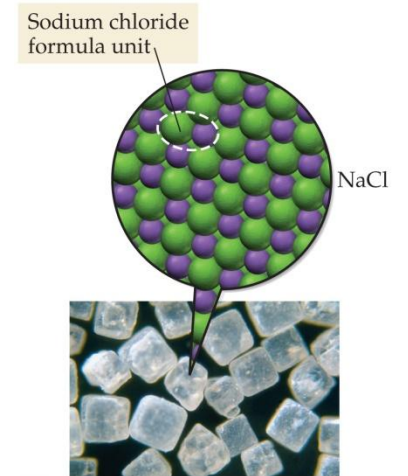
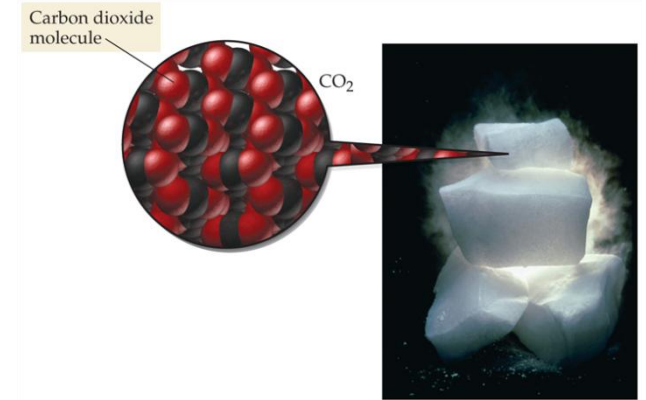
Covalent and Ionic Compounds

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)

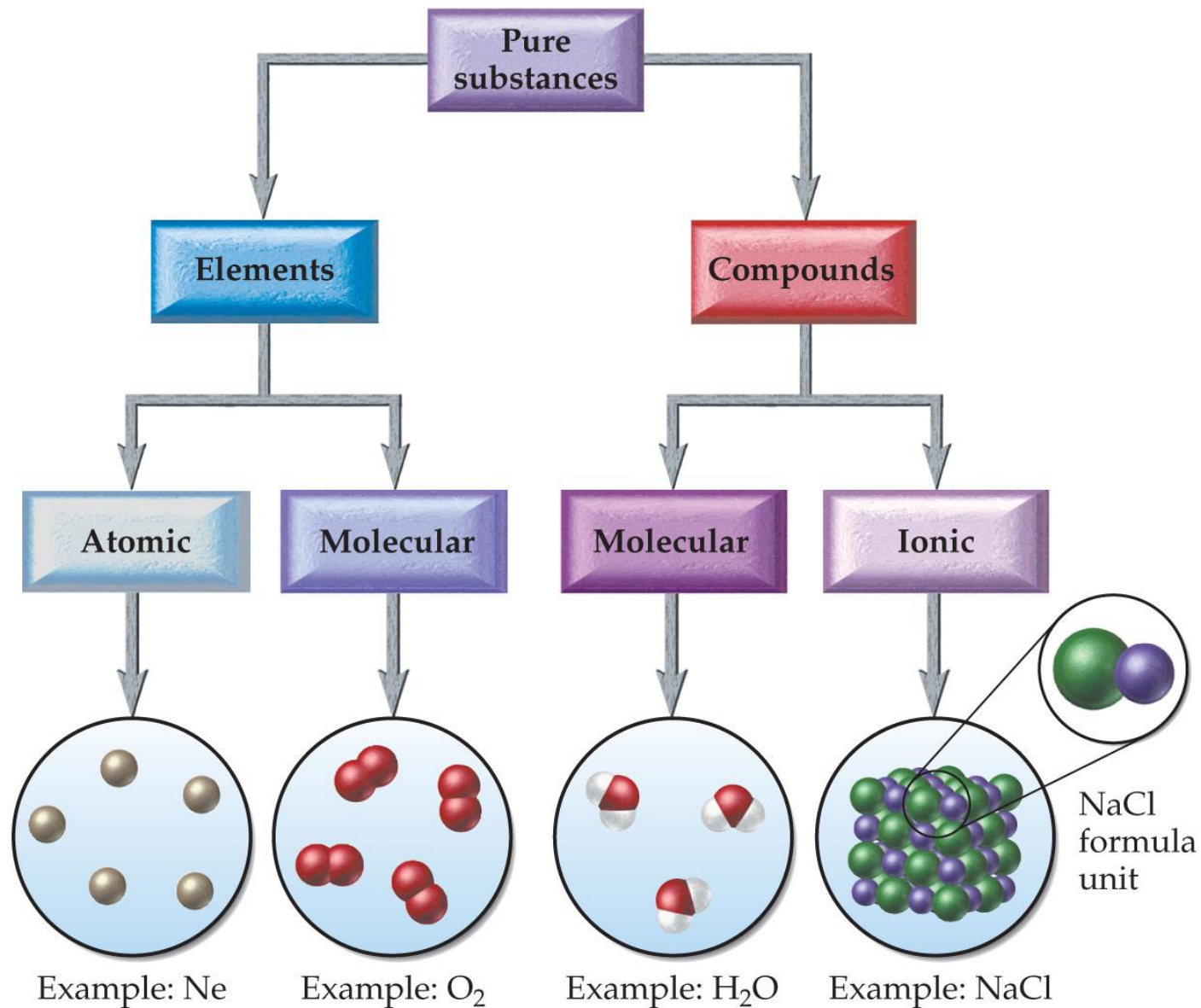
Ionic Compounds: formed from a metal and a nonmetal

Not a real “bond” between ions: just + and – attraction.

metals have positive charge (lose electrons),
nonmetals have negative charge (gain electrons)



Classification of Elements and Compounds



(a) Cl_2

(b) NO

(c) Au

(d) Na_2O

(e) CrCl_3

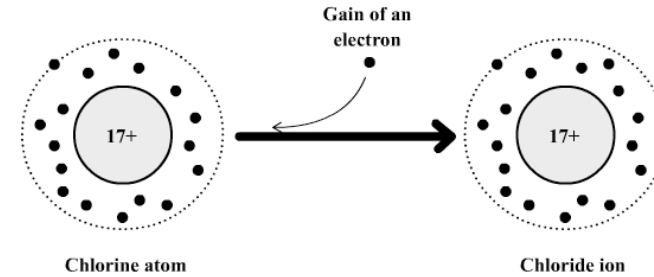
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Ions & ionic compounds

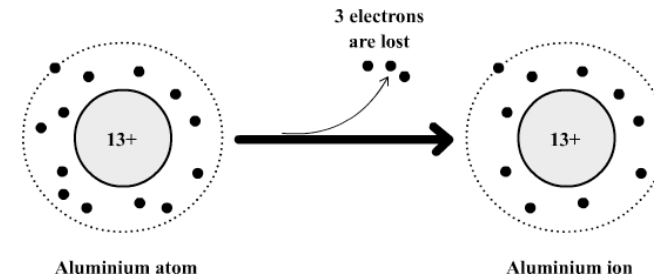


Ions

- Atoms can lose or gain electrons
 - As a result, they become charged
 - Charged atoms are called **ions**
- Loss of electron = positive charge
 - Cation
 - Metal atoms tend to form cations
- Gain of electron = negative charge
 - Anion
 - Nonmetal atoms tend to form anions
- Formulas: superscript charge
- Names: Periodic Table of Ions

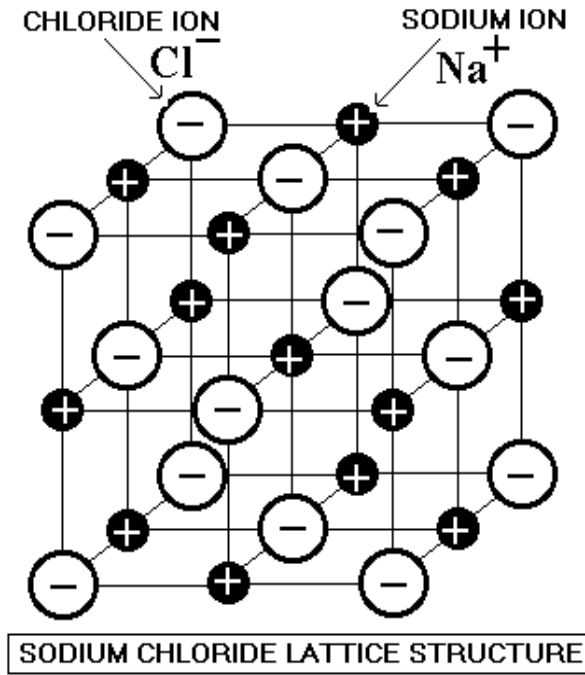


Cl^- (negative charge due to gain of an electron)



Al^{3+} (triply positive charge due to loss of three electrons)

Ionic compounds are made of ionic lattices (they are solids)



- Definite ratio of cations:anions that is infinitely repeating itself
- Crystal structures

Writing Formulas for Ionic Compounds

Ionic compounds are neutral (charges cancel out)

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

Example: Na_xCl_y

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: $\text{Mg}(\text{NO}_3)_2$

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

Practice Exercise: What is the chemical formula of the following ionic compounds containing the listed elements?

1. Magnesium cation and chloride anion:

2. Aluminum cation and oxygen anion:

3. K^+ and CO_3^{2-} :

4. Al^{3+} and SO_4^{2-} :

5. Magnesium cation and oxygen anion:

6. Na^+ and HO^- :