

Chapter 5: The Periodic Table

The **PERIODIC TABLE** [Element song](#)

A Typical Nuclide on the periodic table:

12.011 → Average atomic mass
- Protons + neutrons
- Always a decimal

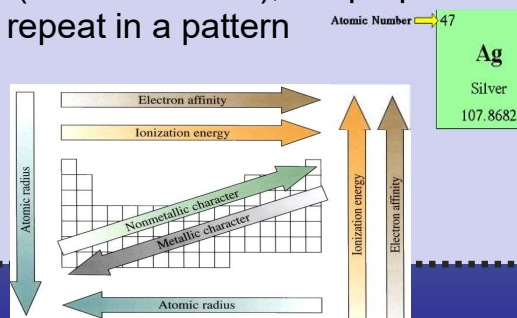
C → Element Symbol
- 1st letter is always capitalized
- 2nd letter is always lowercase

Carbon → Element name

6 → Atomic Number
- number of protons

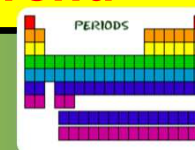
The Modern Periodic Table

- **Periodic Law**- when the elements are arranged in order of increasing number of protons (atomic number), the properties tend to repeat in a pattern



Periodic Table Trend

Periods



- **Period**- a horizontal row of elements in the periodic table.
 - Protons and electrons increases as you move across a period from left to right.
 - Shows how many energy levels the atom has.
 - More metallic from left to right

Periodic Table Trend

Groups

- **Group-** a vertical column of elements in the periodic table.
 - Also called a family
- Have the same properties

B	5
Al	13
Ga	31
In	49
Tl	81

18 individually numbered columns

Valence Electrons

Memorize Valence Electrons Rhyme

• “1+, 2+, 3+, skip, 3-, 2-, 1-, zip”

	1	2		3	4	5	6	7	8	
H•				•B•	•C•	•N•	•O•	•F•	•Ne:	
Li•	•Be•			•Al•	•Si•	•P•	•S•	•Cl•	•Ar:	
K•	•Ca•			•Ga•	•Ge•	•As•	•Se•	•Br•	•Kr:	
Rb•	•Sr•			•In•	•Sn•	•Sb•	•Te•	•I•	•Xe:	
Cs•	•Ba•			•Tl•	•Pb•	•Bi•	•Po•	•At•	•Rn:	
Fr•	•Ra•									

F⁻

This tells you the ionic charge and oxidation numbers for the elements in the 8 REPRESENTATIVE GROUPS, 1A-8A, as you count from left to right.

Valence Electrons

- Grp 1 (1) has 1e-
- Grp 2 (2) has 2e-
- Grp 13 (3) has 3e-
- Grp 14 (4) has 4e-
- Grp 15 (5) has 5e-
- Grp 16 (6) has 6e-
- Grp 17 (7) has 7 e-
- Grp 18 (8) has 8e- (a full octet).

Octet Rule:
• 8 electrons

How many valence electrons does sulfur have?

6

Then what would be its charge?

2-

1	2										
H											
Li	Be			B	C	N	O	F	Ne		
Na	Mg			Al	Si	P	S	Cl	Ar		
K	Ca			Ga	Ge	As	Se	Br	Kr		
Rb	Sr			In	Sn	Sb	Te	I	Xe		
Cs	Ba			Tl	Pb	Bi	Po	At	Rn		
Fr	Ra										

Try This

- Identify the valence electrons.
- Identify the oxidation numbers (charges).

Below the periodic table are two small tables:

* Lanthanide series

La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb
----	----	----	----	----	----	----	----	----	----	----	----	----	----

** Actinide series

Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No
----	----	----	---	----	----	----	----	----	----	----	----	----	----

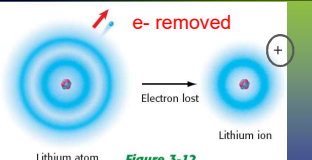
Cation
is positively charged

Ion Formation

The two types of ions are:

Cation- an ion with a positive charge. (+)
Ex) Group 1, 2, 13, transition metals

Left side of periodic table



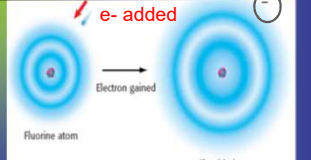
Lithium atom Lithium ion

Figure 3-12

Lithium has one valence electron, so it would rather give it away than collect 7 more electrons to fill its outer energy level.

Anion- an ion with a negative charge (-)
Ex) elements in groups 15, 16, & 17

Right side of periodic table



Fluorine atom Fluoride ion

Fluorine has 7 valence electrons, so it would rather collect 1 more electron to fill its outer energy level, than give 7 away.

Periodic Trends

Phases at Room Temperature

Trends	How is the Trend Organized on the Periodic Table
Location of Gases	18 He Ne Ar K Xe Rn 17 F Cl 16 O 15 N 1 H
Location of Liquids	Hg, Br
Location of Solids	Everything that is not a gas or a liquid.

Phases at Room Temperatures

Periodic Table of the Elements
Natural Form

<http://chemistry.about.com>
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About Chemistry

Solid Liquid Gas

1A	2A																	6A	7A	8A
1	2																	6	7	8
3	4																	9	10	11
Li	Be																	B	C	N
5	6																	12	13	14
11	12																	17	18	19
Na	Mg																	Al	Si	P
13	14																	16	17	18
19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36			
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr			
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54			
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe			
55	56	57-71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86			
Cs	Ba	Lanthanides					Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb			
87	88	89-103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118			
Fr	Ra	Actinides					Rn	Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf			
101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118			

*** Elements > 104 exist only for very short half-lives and the data is unknown.***

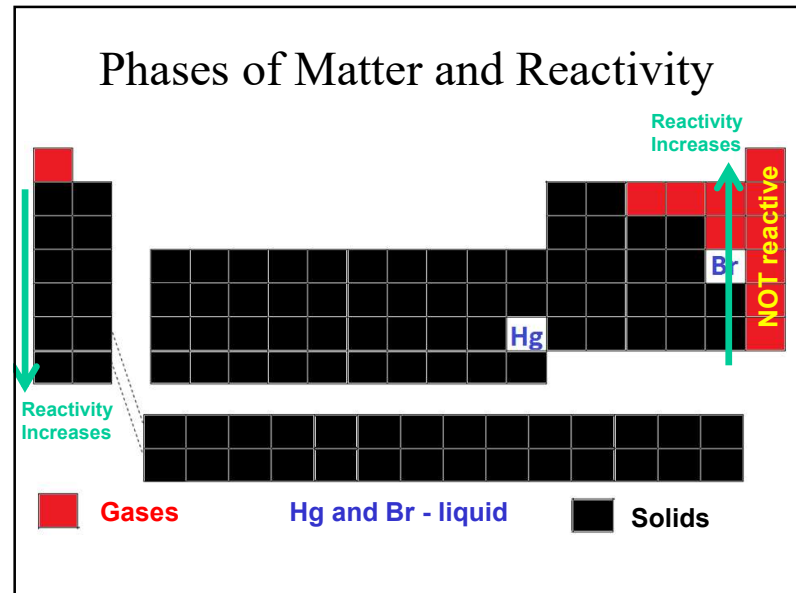
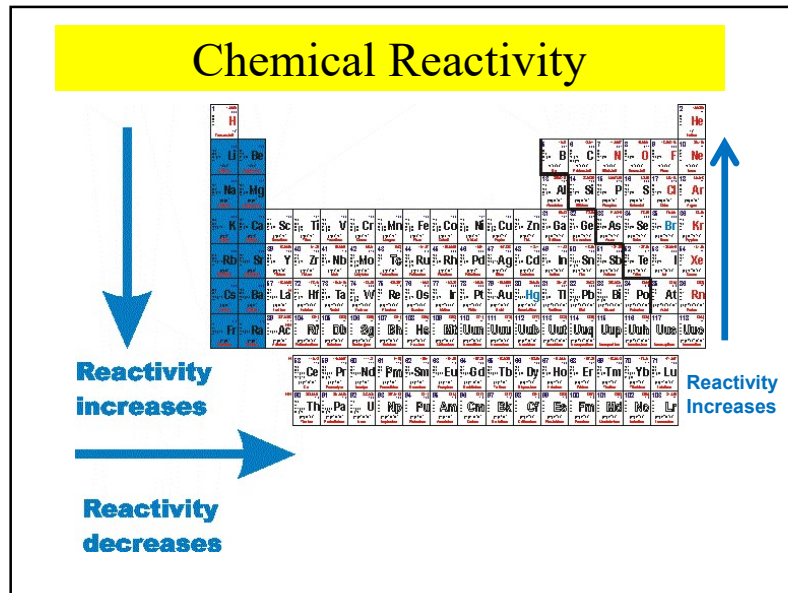
Most stable crystalline structure of solids

CUBIC Simple Cubic FCC Face Centered Cubic OHTHP Orthorhombic TETRA Tetragonal UNK Unknown
BCC Body Centered Cubic HEX Hexagonal RHOH Rhombohedral MONO Monoclinic

Periodic Trends

Chemical Reactivity- how likely an atom will react with other substances

Trends	How is the Trend Organized on the Periodic Table
Reactivity of Group 1	Increases as you go down the group. (Metals) Highly reactive (Cesium & Francium)
Reactivity of group 17	Increases as you go up the group (Non-metals) Highly reactive (Fluorine)



• Three main categories of elements:

Semiconductors																			
Metals										Metalloids				Nonmetals					
1	2												13	14	15	16	17	18	
1	H												5	6	7	8	9	10	
3	Li	4											13	14	15	16	17	18	
11	Na	12											31	32	33	34	35	36	
19	K	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	
37	Rb	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	
55	Cs	56	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	
87	Fr	88	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	
Lanthanide series			57	58	59	60	61	62	63	64	65	66	67	68	69	70			
Actinide series			89	90	91	92	93	94	95	96	97	98	99	100	101	102			

How Are Elements Classified?

Metals

- Characteristics:
 - Good conductors of heat and electricity
 - Shiny
 - Malleable- can be flattened into sheets
 - Ductile- can be stretched or shaped into wires
 - Most are solids at room temperature.
 - Tend to lose electrons
 - Ex: Copper and Lead



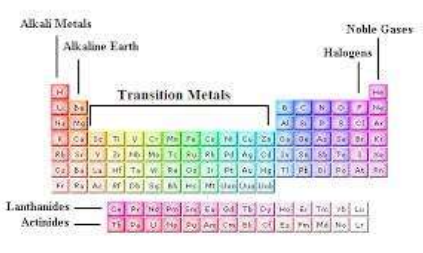



Metals

Shiny

Malleable


- Families of metals:
 - Alkali metals
 - Alkaline-earth metals
 - Transition metals



Metals

Alkali Metals

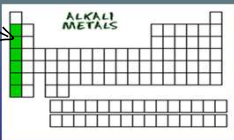
Least Reactive



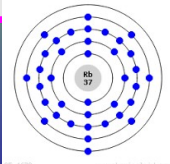
- **Group 1**
- **Very reactive**
- **1 valence electron**
- **Form positive ions because electron is easily removed. +1**

H	
Li	Lithium
Na	Sodium
K	Potassium
Rb	Rubidium
Cs	Cesium
Fr	Francium

Most Reactive



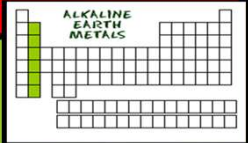
ALKALI METALS



Rb
37


Metals

Alkaline- earth metals



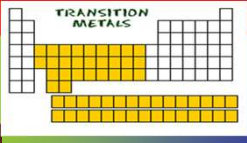
ALKALINE
EARTH
METALS

- Group 2
- Are harder, denser, stronger, and have higher melting points than alkali metals.
- Highly reactive, but not as much as alkali metals
- 2 valence e-. Form positive ion 2+
- **Not found uncombined in nature.**
 - Calcium makes up seashells, corals, bones & teeth.






Metals

Transition Metals



TRANSITION
METALS

- Groups 3-12
- Less reactive
- Usually found alone (not in compound form)
- Can lose 1, 2, or 3 e- to form cations
 - They can use the inner shell electrons to bond before using the outer shell.
- Are harder, more dense, and have higher melting points than alkali or alkaline metals (except mercury which is a liquid at room temp).
- Used in jewelry, plumbing, light bulb filaments.

Transition Metals

Good conductors

Malleable and ductile

High Density

High Luster (shiny)

Conducts heat well

Most solid

Except Hg

How Are Elements Classified?

Metalloids (Semi-Conductors)

- **Characteristics:**
 - Varying ability to conduct electricity
 - semiconductors-main components of chips in computers and electronic devices.
 - Share properties of metals and nonmetals.

Figure 3-29
Silicon wafers are the basic building blocks of computer chips.

Metalloids

Semiconductors

Metalloids/Semiconductors

Semi-conductor



Brittle



Can luster



Determine the number of valence electrons, which energy level is filling, metal or nonmetal or metalloid, and phase of matter for:

Valence e- Charge Energy level Phase

1. Cs

2. Xe

1																	2	
1	H																	He
2	Li	Be											B	C	N	O	F	Ne
3	Na	Mg											Al	Si	P	S	Cl	Ar
4	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
5	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
6	Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
7	Fr	Ra	Lr	Rf	Db	Sg	Bh	Hs	Mt	Uun	Uuu	Uub	Uuc					
Lanthanide series			57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72
Actinide series			89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104

How Are Elements Classified?

Non Metals

- **Characteristics:**
 - Poor conductors of heat and electricity
 - Mostly dull (not shiny)
 - Brittle, not malleable or ductile
 - Many are gases at room temperature.
 - Tend to gain electrons



Families
Halogens,
Noble Gases, &
Hydrogen

NonMetals

Poor Conductors of electricity



Dull in color (no shine)



Transparent/Translucent



Brittle (break when hit)




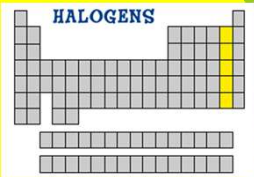
Poor conductors on heat




NonMetals

Families of nonmetals:

1. Oxygen Family
2. Nitrogen Family
3. Carbon family
4. Halogens
 - Group 17 and are very reactive.
 - Poisonous as gas, but form compounds that are very useful.



NonMetals

Families of nonmetals:

5. The Noble Gases

- Full valence shell (8 electrons). Octet rule
 - Except Helium
- Do not react at all with any other elements.
- Colorless, odorless gases at room temp
- Glow brightly when electricity passes through them.

He: $1s^2$

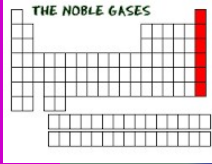

Ne: $1s^2 2s^2 2p^6$

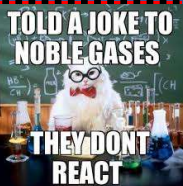
Ar: $1s^2 2s^2 2p^6 3s^2 3p^6$

Kr: $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 4p^6$

Xe: $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 4p^6 5s^2 5p^6$

Rn: $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 4p^6 5s^2 5p^6 6s^2 6p^6$



What About Hydrogen?

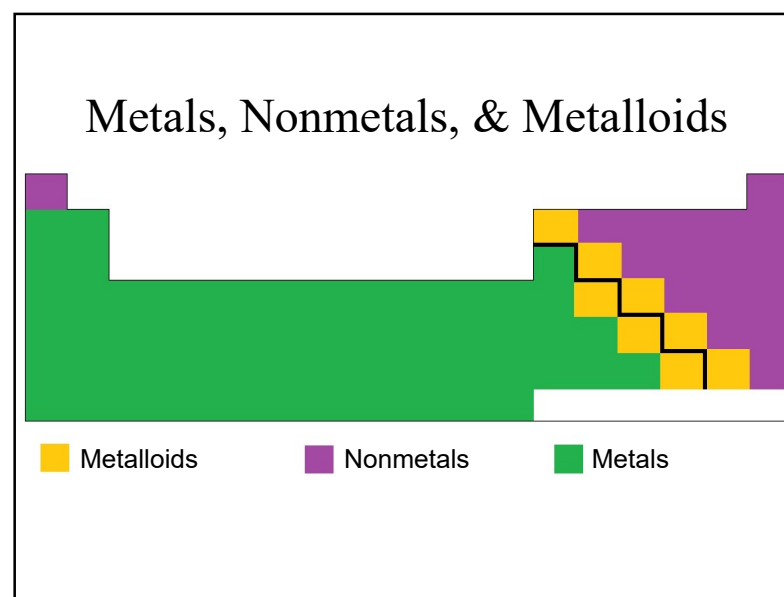
6. Hydrogen Family stands alone

1
H
Hydrogen
1.00794

Reactive

**Colorless,
odorless gas at
room temp**

**Explosive
reaction with
oxygen**



Practice

element	Valence e-	Energy levels	Metal/ non-metal/ metalloid	phase
At	7	6	Metalloid	Solid
Sb	5	5	Metalloid	Solid
Sr	2	5	Metal	Solid
Rb	1	5	Metal	Solid
Ne	8	2	Non-metal	Gas

Practice

element	Valence e-	Energy levels	Metal/ non-metal/ metalloid	phase
Hg	1,2 or 3	6	Metal	Liquid
F	7	2	Non-metal	Gas
Li	1	2	Metal	Solid
Ti	1, 2 or 3	4	Metal	Solid
Ra	2	7	Metal	Solid

Determine the number of valence electrons, which energy level is filling, metal or nonmetal or metalloid, and phase of matter for:

	Valence e-	Energy level	metal?	Phase
1. Cs				
2. Si				
3. I				
4. Ru				

Manganese (Mn)

- Valence Electrons • **Varies**
- Number of Energy Levels • **4**
- Metal, Nonmetal or Metalloid? • **Metal**
- Phase • **Solid**

Bromine (Br)

- Valence Electrons • 7
- Number of Energy Levels • 4
- Metal, Nonmetal or Metalloid? • Nonmetal
- Phase • Liquid

Nitrogen (N)

- Valence Electrons • 5
- Number of Energy Levels • 2
- Metal, Nonmetal or Metalloid? • Nonmetal
- Phase • Gas

Cesium (Cs)

- Valence Electrons • 1
- Number of Energy Levels • 6
- Metal, Nonmetal or Metalloid? • Metal
- Phase • Solid

Radon (Rn)

- Valence Electrons • 8
- Number of Energy Levels • 6
- Metal, Nonmetal or Metalloid? • Nonmetal
- Phase • Gas

Silicon (Si)

- Valence Electrons • 4
- Number of Energy Levels • 3
- Metal, Nonmetal or Metalloid? • Metalloid
- Phase • Solid

Bohrium (Bh)

- Valence Electrons • varies
- Number of Energy Levels • 7
- Metal, Nonmetal or Metalloid? • Metal
- Phase • Solid

Radium (Ra)

- Valence Electrons • 2
- Number of Energy Levels • 7
- Metal, Nonmetal or Metalloid? • Metal
- Phase • Solid

Tin (Sn)

- Valence Electrons • 4
- Number of Energy Levels • 5
- Metal, Nonmetal or Metalloid? • Metal
- Phase • Solid

Aluminum (Al)

- Valence Electrons • 3
- Number of Energy Levels • 3
- Metal, Nonmetal or Metalloid? • Metal
- Phase • Solid

Astatine (At)

- Valence Electrons • 7
- Number of Energy Levels • 6
- Metal, Nonmetal or Metalloid? • Metalloid
- Phase • Solid

Mercury (Hg)

- Valence Electrons • varies
- Number of Energy Levels • 6
- Metal, Nonmetal or Metalloid? • Metal
- Phase • Liquid