

# IPC Unit 8 Lecture 4:

**Periodic Table of the Elements**

Atomic Number  
 Symbol  
 Name  
 Atomic Mass

1 1A <b>H</b> Hydrogen 1.008	2 2A <b>He</b> Helium 4.003																	18 VIII A <b>He</b> Helium 4.003					
3 <b>Li</b> Lithium 6.941	4 <b>Be</b> Beryllium 9.012																	5 <b>B</b> Boron 10.811	6 <b>C</b> Carbon 12.011	7 <b>N</b> Nitrogen 14.007	8 <b>O</b> Oxygen 15.999	9 <b>F</b> Fluorine 18.998	10 <b>Ne</b> Neon 20.180
11 <b>Na</b> Sodium 22.990	12 <b>Mg</b> Magnesium 24.305	3 IIIB <b>Sc</b>	4 IVB <b>Ti</b>	5 VB <b>V</b>	6 VIB <b>Cr</b>	7 VIIB <b>Mn</b>	8 VIII <b>Fe</b>	9 VIII <b>Co</b>	10 VIII <b>Ni</b>	11 IB <b>Cu</b>	12 IIB <b>Zn</b>	13 <b>Al</b> Aluminum 26.982	14 <b>Si</b> Silicon 28.086	15 <b>P</b> Phosphorus 30.974	16 <b>S</b> Sulfur 32.066	17 <b>Cl</b> Chlorine 35.453	18 <b>Ar</b> Argon 39.948						
19 <b>K</b> Potassium 39.098	20 <b>Ca</b> Calcium 40.078	21 <b>Sc</b> Scandium 44.956	22 <b>Ti</b> Titanium 47.88	23 <b>V</b> Vanadium 50.942	24 <b>Cr</b> Chromium 51.996	25 <b>Mn</b> Manganese 54.938	26 <b>Fe</b> Iron 55.833	27 <b>Co</b> Cobalt 58.933	28 <b>Ni</b> Nickel 58.693	29 <b>Cu</b> Copper 63.546	30 <b>Zn</b> Zinc 65.39	31 <b>Ga</b> Gallium 69.723	32 <b>Ge</b> Germanium 72.61	33 <b>As</b> Arsenic 74.922	34 <b>Se</b> Selenium 78.972	35 <b>Br</b> Bromine 79.904	36 <b>Kr</b> Krypton 84.80						
37 <b>Rb</b> Rubidium 84.468	38 <b>Sr</b> Strontium 87.62	39 <b>Y</b> Yttrium 88.906	40 <b>Zr</b> Zirconium 91.224	41 <b>Nb</b> Niobium 92.906	42 <b>Mo</b> Molybdenum 95.95	43 <b>Tc</b> Technetium 98.907	44 <b>Ru</b> Ruthenium 101.07	45 <b>Rh</b> Rhodium 102.906	46 <b>Pd</b> Palladium 106.42	47 <b>Ag</b> Silver 107.868	48 <b>Cd</b> Cadmium 112.411	49 <b>In</b> Indium 114.818	50 <b>Sn</b> Tin 118.71	51 <b>Sb</b> Antimony 121.760	52 <b>Te</b> Tellurium 127.6	53 <b>I</b> Iodine 126.904	54 <b>Xe</b> Xenon 131.29						
55 <b>Cs</b> Cesium 132.905	56 <b>Ba</b> Barium 137.327	57-71 Lanthanide Series	72 <b>Hf</b> Hafnium 178.49	73 <b>Ta</b> Tantalum 180.948	74 <b>W</b> Tungsten 183.85	75 <b>Re</b> Rhenium 186.207	76 <b>Os</b> Osmium 190.23	77 <b>Ir</b> Iridium 192.22	78 <b>Pt</b> Platinum 195.08	79 <b>Au</b> Gold 196.967	80 <b>Hg</b> Mercury 200.59	81 <b>Tl</b> Thallium 204.383	82 <b>Pb</b> Lead 207.2	83 <b>Bi</b> Bismuth 208.980	84 <b>Po</b> Polonium [209]	85 <b>At</b> Astatine 209	86 <b>Rn</b> Radon 222.018						
87 <b>Fr</b> Francium 223.020	88 <b>Ra</b> Radium 226.025	89-103 Actinide Series	104 <b>Rf</b> Rutherfordium [261]	105 <b>Db</b> Dubnium [262]	106 <b>Sg</b> Seaborgium [266]	107 <b>Bh</b> Bohrium [264]	108 <b>Hs</b> Hassium [269]	109 <b>Mt</b> Meitnerium [268]	110 <b>Ds</b> Darmstadtium [289]	111 <b>Rg</b> Roentgenium [272]	112 <b>Cn</b> Copernicium [277]	113 <b>Uut</b> Ununtrium unknown	114 <b>Fl</b> Flerovium [289]	115 <b>Uup</b> Ununpentium unknown	116 <b>Lv</b> Livermorium [293]	117 <b>Uus</b> Ununseptium unknown	118 <b>Uuo</b> Ununoctium unknown						
		57 <b>La</b> Lanthanum 138.906	58 <b>Ce</b> Cerium 140.115	59 <b>Pr</b> Praseodymium 140.908	60 <b>Nd</b> Neodymium 144.24	61 <b>Pm</b> Promethium 144.913	62 <b>Sm</b> Samarium 150.36	63 <b>Eu</b> Europium 151.966	64 <b>Gd</b> Gadolinium 157.25	65 <b>Tb</b> Terbium 158.925	66 <b>Dy</b> Dysprosium 162.50	67 <b>Ho</b> Holmium 164.930	68 <b>Er</b> Erbium 167.26	69 <b>Tm</b> Thulium 168.934	70 <b>Yb</b> Ytterbium 173.04	71 <b>Lu</b> Lutetium 174.967							
		89 <b>Ac</b> Actinium 227.028	90 <b>Th</b> Thorium 232.038	91 <b>Pa</b> Protactinium 231.036	92 <b>U</b> Uranium 238.029	93 <b>Np</b> Neptunium 237.048	94 <b>Pu</b> Plutonium 244.064	95 <b>Am</b> Americium 243.061	96 <b>Cm</b> Curium 247.070	97 <b>Bk</b> Berkelium 247.070	98 <b>Cf</b> Californium 251.080	99 <b>Es</b> Einsteinium [254]	100 <b>Fm</b> Fermium 257.095	101 <b>Md</b> Mendelevium 258.1	102 <b>No</b> Nobelium 259.101	103 <b>Lr</b> Lawrencium [262]							

Alkali Metal

Alkaline Earth

Transition Metal

Basic Metal

Semimetal

Nonmetal

Halogen

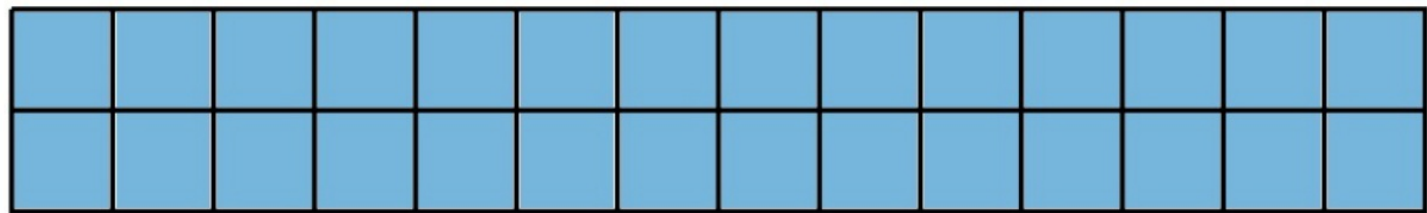
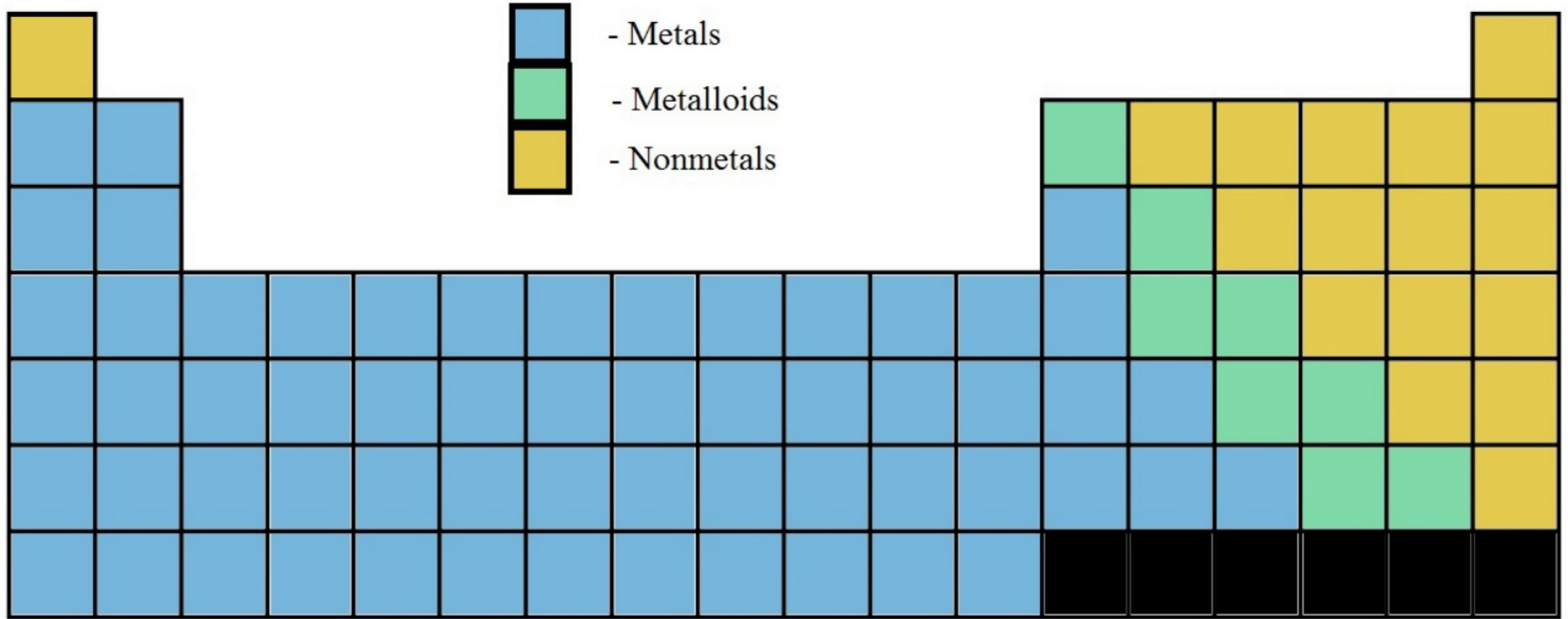
Noble Gas

Lanthanide

Actinide

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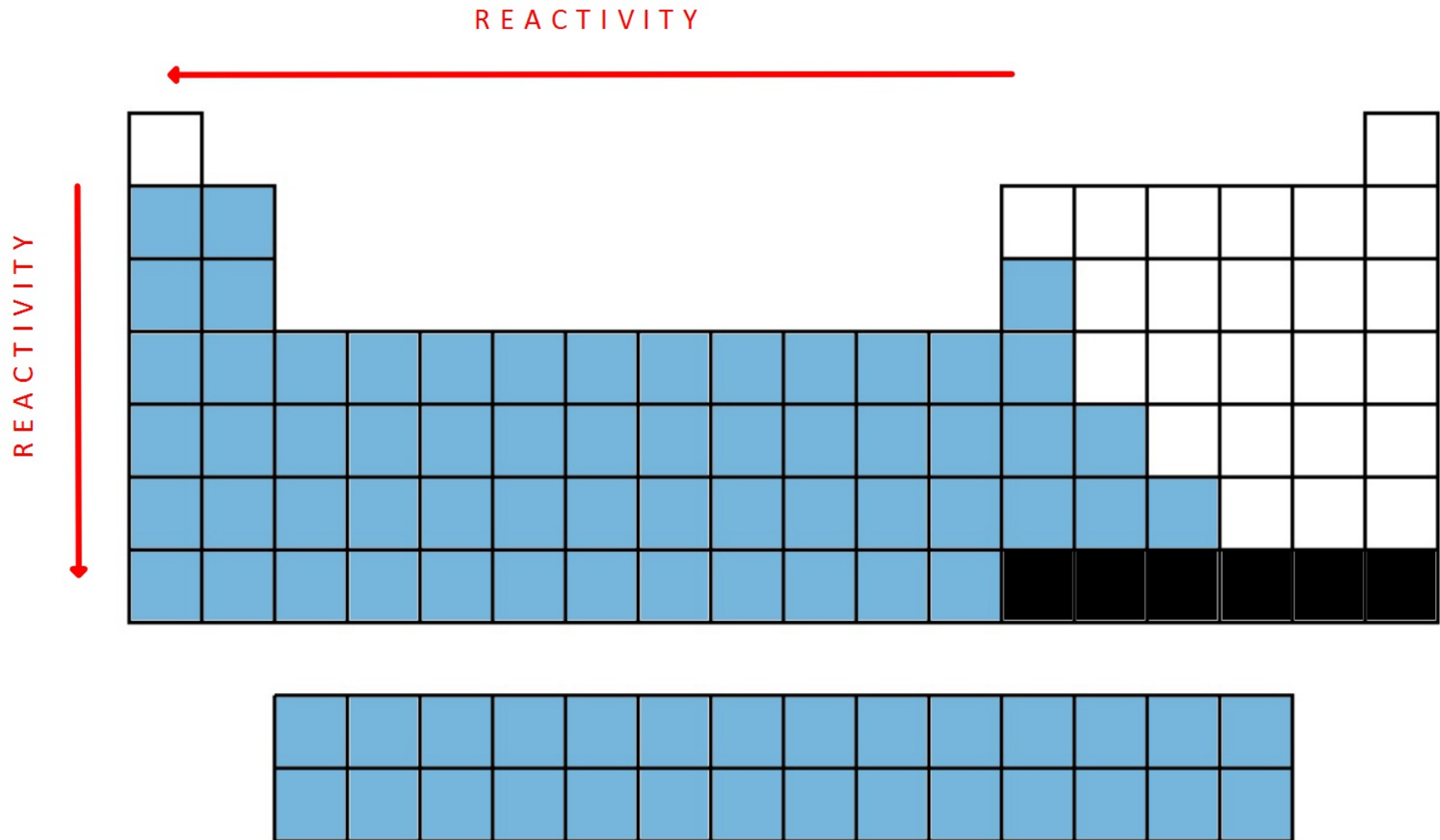
# Periodic Table of Elements and Their Properties



# Metals



# Metals



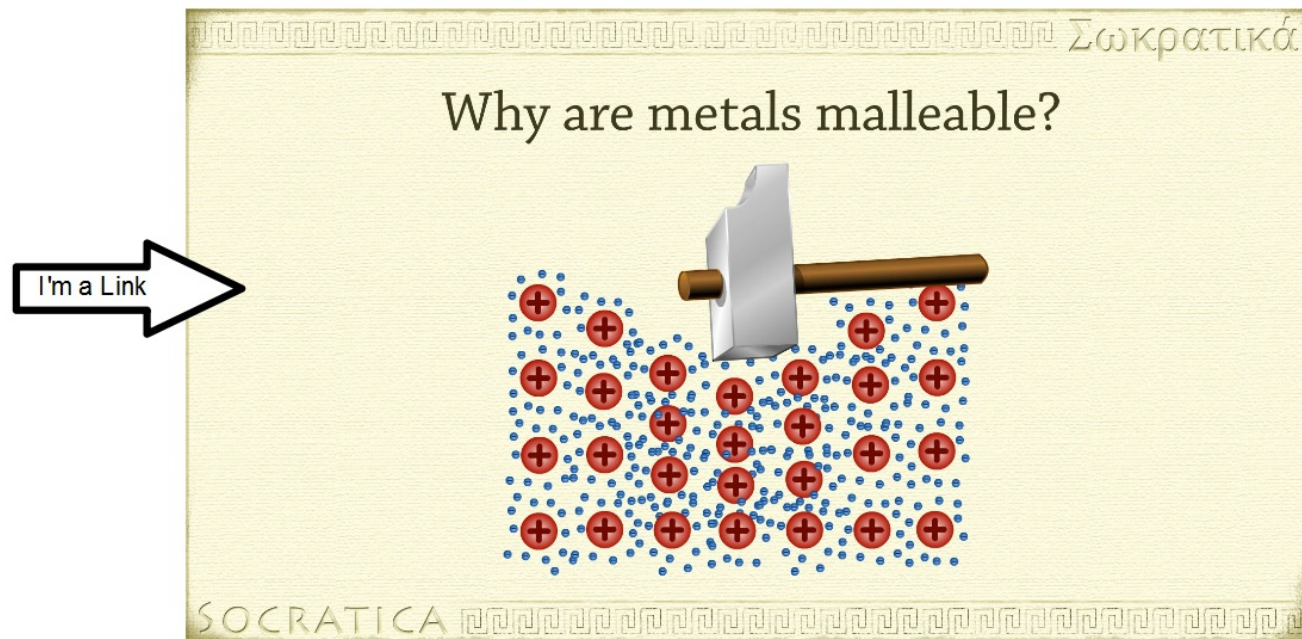
## Bonding in Metals

### Metal + Nonmetal

- Generally forms an Ionic Bond (more on this later) with the metal positively (+) charged and the nonmetal negatively (-) charged

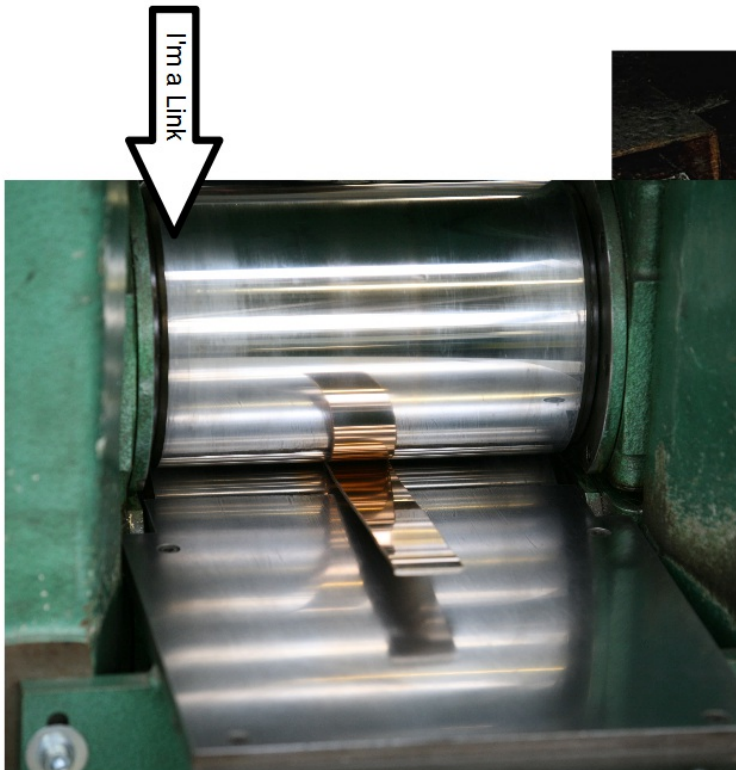
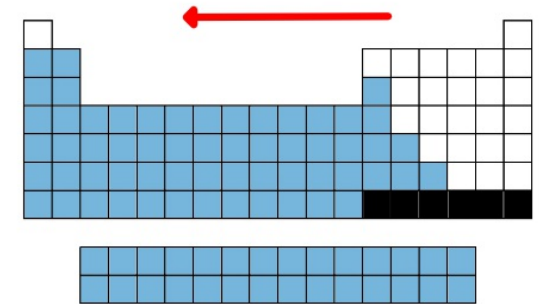
### Metallic Bonding

- **Metallic Bonding**: positively charged metallic ions are surrounded by a sea of electrons
- Outer-level electrons are not held tightly to the nucleus of an atom but move freely among many positively charged ions.
- Metallic Bonding explains many of the properties of metals (i.e. malleability, ductility, as well as their conductivity with both electricity and heat).



## Properties of Metals

- **Metals:** elements that are shiny, malleable, ductile, and good conductors of heat and electricity.
- Except for Mercury (Hg), metals are solid at room temperature.
- **Malleable:** the ability of a substance to be hammered or rolled into sheets
- **Ductile:** the ability of a substance to be drawn into wires
- On the periodic table, metals are found **to the left** of the stair-step line



## The Alkali Metals

### Properties:

- Like other metals, they are: shiny, malleable, ductile, and good conductors of heat & electricity
- Generally softer than other metals
- Are **the most reactive** group of metals
  - Francium is the most reactive Metal
- Elements become more reactive as you go down (↓) the group
- Each element has 1 valence shell electron in its outer ring

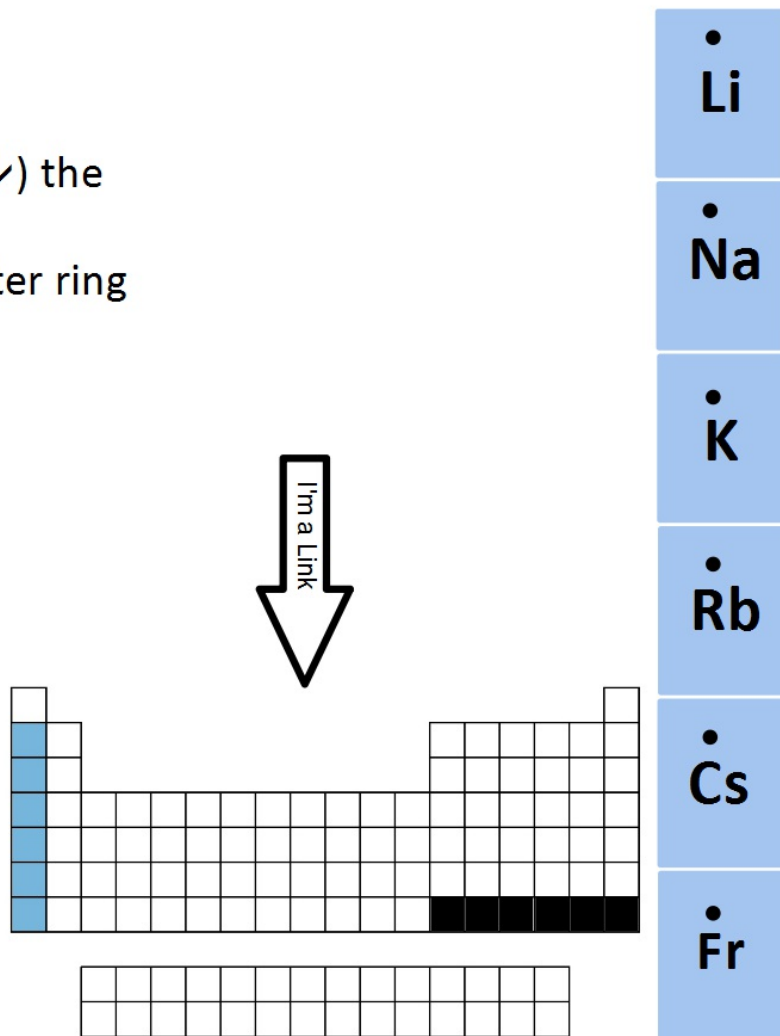
### Random Facts

- They are so reactive that they don't occur naturally in their elemental form
- Pure samples have to be stored in oil to prevent reactions with oxygen and H<sub>2</sub>O in the air.
- Sodium and Potassium are need by most living things to live healthy
- Lithium can be used to help treat Bipolar Disorder
- Rubidium and Cesium can be used in the operation of some light-detecting sensors.
- Cesium is used in Atomic Clocks because some isotopes are radioactive
- Francium is also radioactive and extremely rare.

Oxidation # → 1+

Roman Numeral → I

Group # → 1



## The Alkaline Earth Metals

### Properties:

- Like other metals, they are: shiny, malleable, ductile, and good conductors of heat & electricity
- Like the Alkali metals, they tend to combine readily with other elements and are not found as free elements in nature.
- Each Alkaline Earth Metal has two valence shell electrons in its outer ring

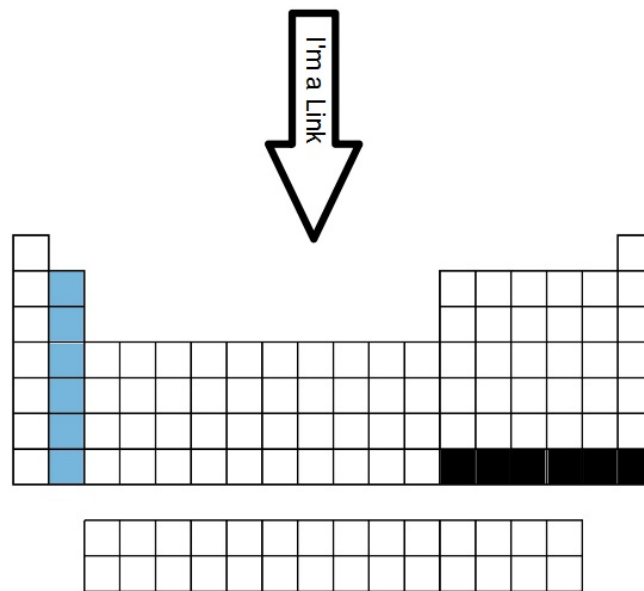
### Random Facts

- Some compounds that have Alkaline Earth Metals in them are used to color fireworks
- Chlorophyll is a Magnesium-containing compound that most life on Earth depends upon
- Calcium is seldom used as a free metal, but its compounds are useful and essential for life (ex: bones in your body, limestone, and marble)
- Barium is in a compound used with x-rays to diagnose digestive disorders
- Radium is radioactive and was once used to treat cancers but is being replaced with more readily available radioactive elements

Oxidation #  $\rightarrow 2+$

Roman Numeral  $\rightarrow II$

Group #  $\rightarrow 2$



Stop at 2:43 playtime



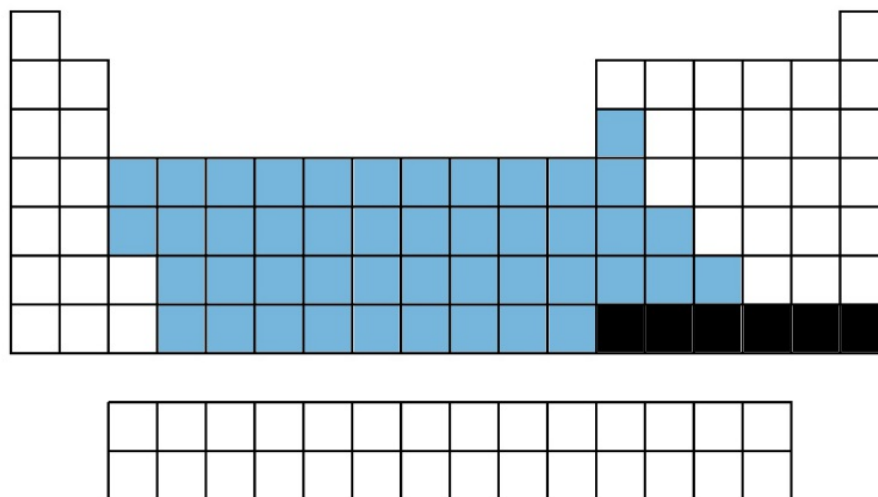
## Transition Metals

### Properties:

- Are called transition elements because they are considered to be in transition between the main group elements (Main groups are Groups 1 & 2 plus Groups 13 thru 18)
- Are less reactive than Group 1 & 2 metals
- They often occur in nature as uncombined elements

### Random Facts

- Iron is the 2nd most abundant metal in Earth's crust and the most widely used of all the metals
- Iron, Cobalt, and Nickel are the most common magnetic elements and are used in steel and other metal mixtures
- Copper, Silver, and Gold are called "coinage metals" because of their stability, malleability, and availability as free elements in nature.
- Mercury is the only metal that is a liquid at room temperature; it is very toxic and because of this, it is rarely used anymore.

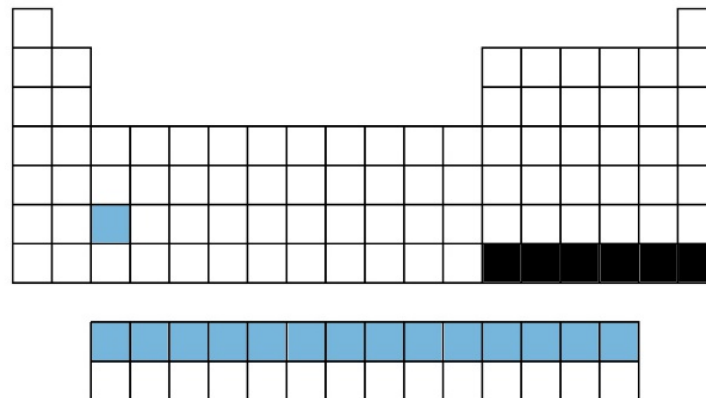


## The Inner Transition Metals

These are the two rows of elements disconnected from the rest of the periodic table (moved to save room)

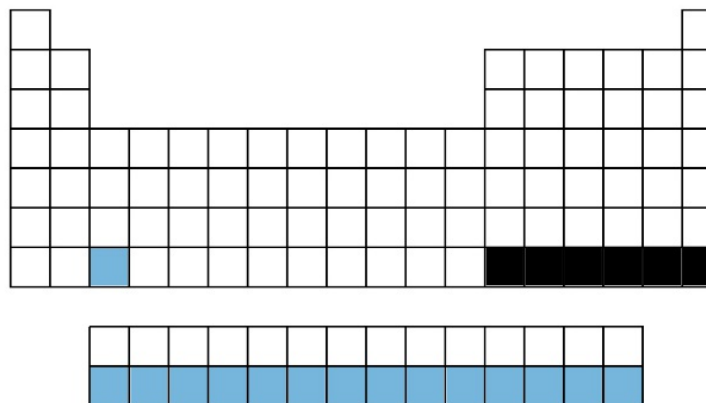
### The Lanthanide Series

- First row of Inner Transition Metals (Atomic #'s 58 - 71)
- They are called the Lanthanide Series because they follow the element Lanthanum on the periodic table



### The Actinide Series

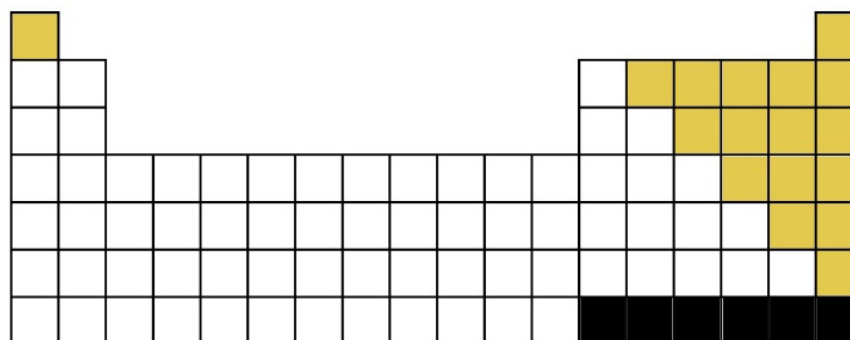
- Second row of Inner Transition Metals (Atomic #'s 90 - 103)
- They are called the Actinide series because they follow the element Actinium on the periodic table
- **All are radioactive** and unstable
- Because they are unstable, they are rare in nature and make it difficult to use them in research.
- Thorium and Uranium are the only Actinides found in the Earth's crust in usable quantities



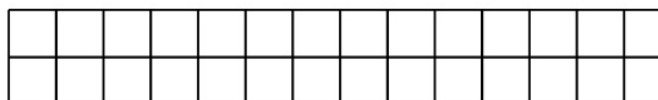


## Properties of Nonmetals

- These elements are usually gases or solids at room temperature
- The solid nonmetals are not malleable nor are they ductile, but they are brittle and/or powdery
- Nonmetals are poor conductors of heat and electricity because the electrons in nonmetals are not free to move as they do in metals
- On the periodic table all nonmetals, except hydrogen, are found to **the right** of the stair-step line



## Bonding in Nonmetals



- Nonmetals become negatively (-) charged ions when they gain electrons from metals (Ionic Bonds)
- When nonmetals bond with other nonmetals, they usually share electrons (called Covalent Bonds; more on this later)

# Hydrogen

Oxidation #  $\rightarrow 1+$

Roman Numeral  $\rightarrow I$

Group #  $\rightarrow 1$

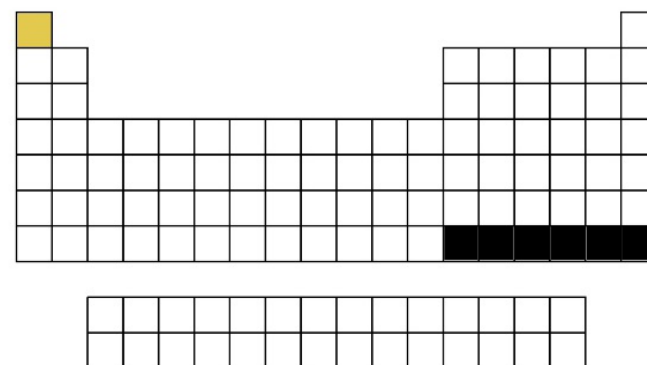
## Properties

- Is highly reactive
- Has 1 valence electron
- Exists as a diatomic molecule by itself
  - **Diatomic Molecule:** consist of two atoms of the same element in a covalent bond
- When combined with other Nonmetals, it shares its 1 electron
- When combined with Alkali or Alkaline Earth Metals it can gain an electron; we call these compounds *hydrides*.



## Random Facts

- Makes up about 90% of all atoms in the universe
- On Earth, most Hydrogen is found in water (where it gets its name from; *hydro* in Greek means water)



# The Halogens

## Properties

- The most reactive of the Nonmetals; they are highly reactive in their elemental form
- These elements gain reactivity as you move up (↑) in the group
- All elements in this group have 7 valence shell electrons
- If a Halogen gains an electron from a Metal, then a salt is formed
- In gaseous state they form diatomic molecules and can be identified by their distinctive colors.
- F, Cl, Br, & I are all diatomic molecules in nature (F<sub>2</sub>, Cl<sub>2</sub>, Br<sub>2</sub>, & I<sub>2</sub>)

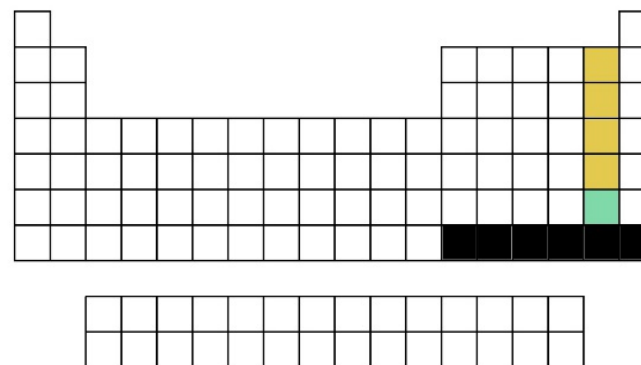
## Random Facts

- Fluorides are used in toothpastes and city water systems to help prevent tooth decay.
- Chlorine is the most abundant halogen; used to disinfect water in swimming pools and city water systems
- Bromine is the only nonmetal that is a liquid at room temperature; Bromine compounds can be used to stain DNA strands and act as markers or tags.
- Iodine is essential to a healthy thyroid and some Iodine compounds are used as disinfectants
- Astatine is radioactive and rare but has many of the same properties of the other halogens

Oxidation # → 1-

Roman Numeral → VII

Group # → 17



# The Noble Gases

## Properties

- Have a full outer valence shell, which makes them completely stable
- Because of this they exist as isolated atoms
- No known naturally occurring compounds have Noble Gases within them

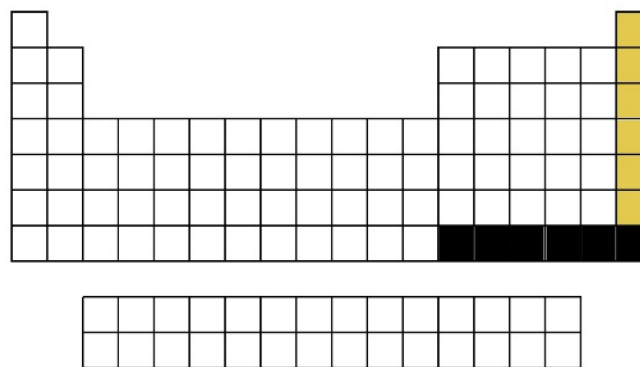
## Random Facts

- Helium is lighter than air but doesn't burn in oxygen, which makes it safer than Hydrogen to use in blimps
- Noble Gases are often used in lasers

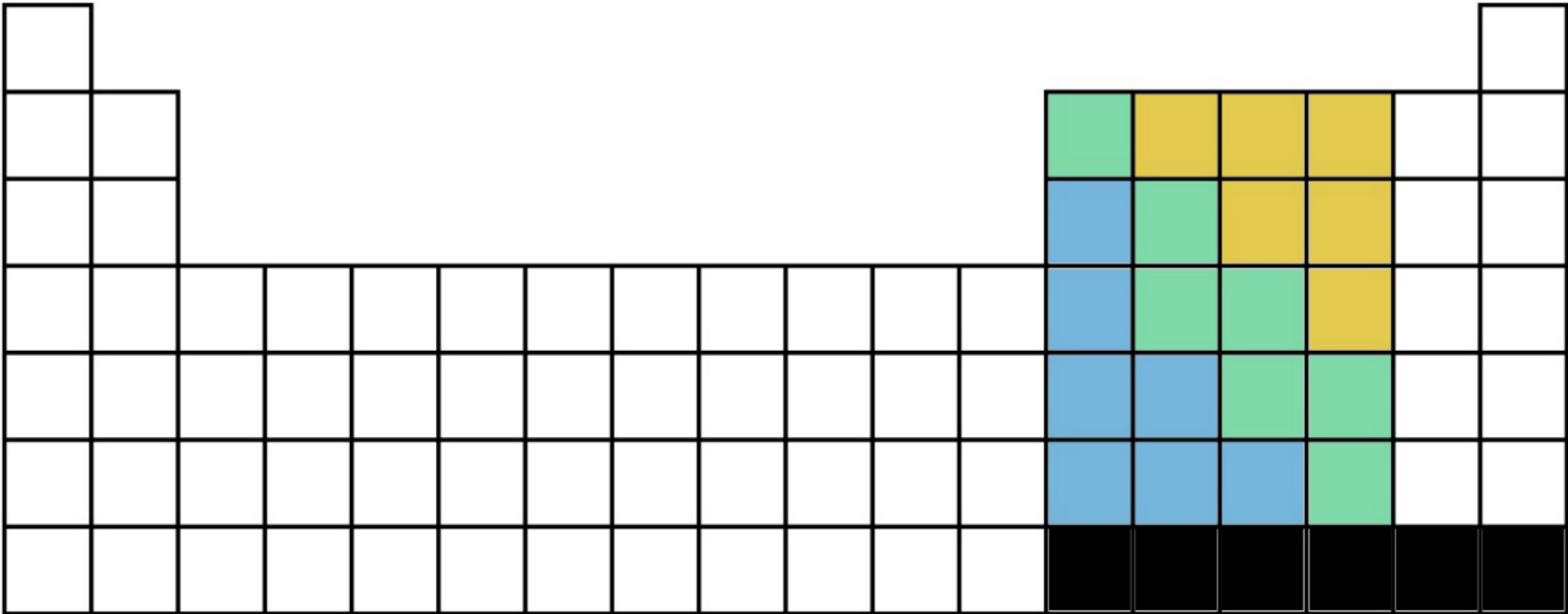
Oxidation #  $\rightarrow$  0

Roman Numeral  $\rightarrow$  VIII

Group #  $\rightarrow$  18



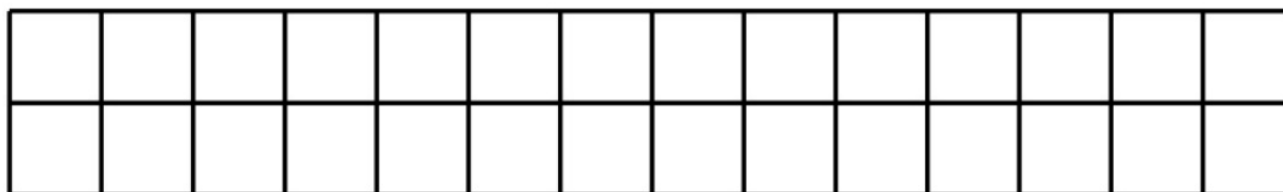
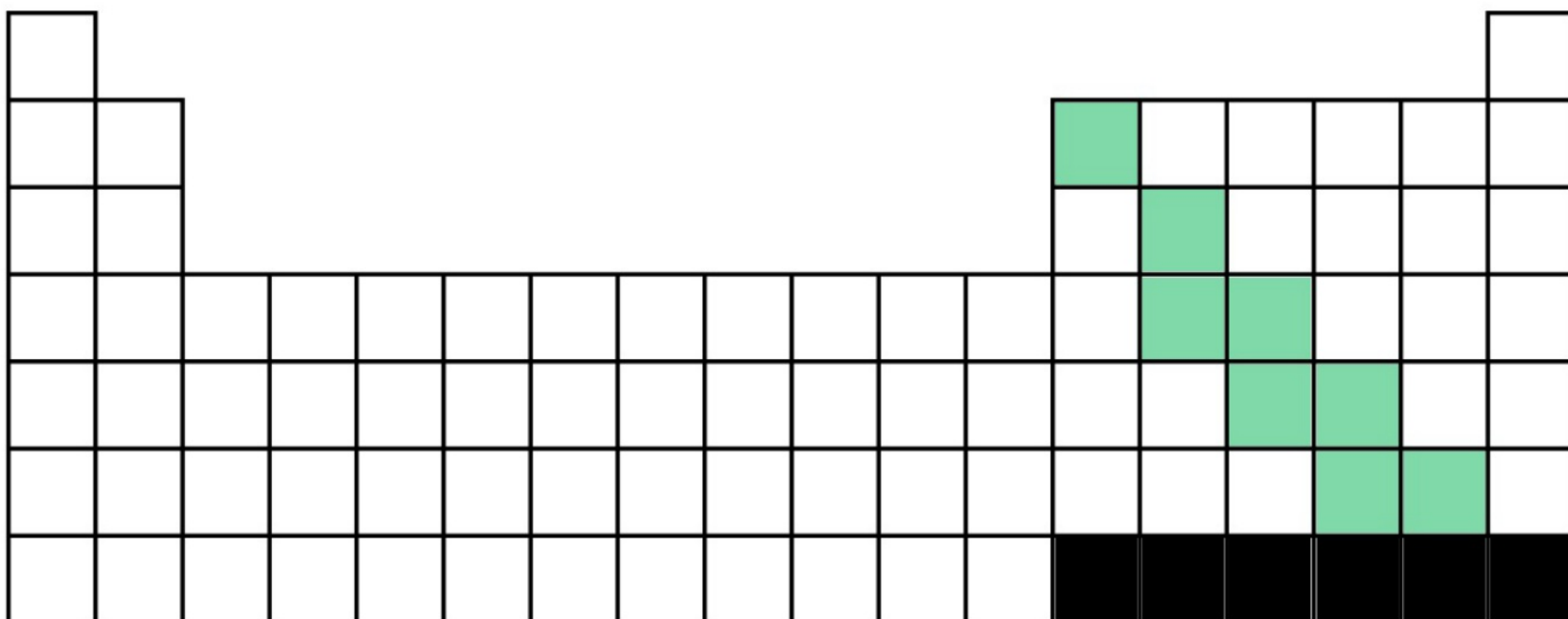
# Mixed Groups





## Properties of Metalloids

- **Metalloids:** are elements that have some properties of metals and some properties of nonmetals
- They can form ionic and/or covalent bonds
- Some metalloids can conduct electricity better than nonmetals but not as well as many metals
- Located **along the stair-step**



# The Boron Group

Oxidation #  $\rightarrow$  3+

Roman Numeral  $\rightarrow$  III

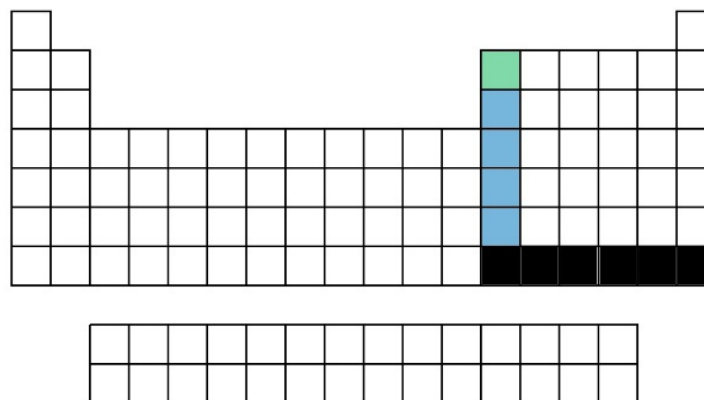
Group #  $\rightarrow$  13

## Properties

- Boron and Aluminum have 3 valence shell electrons
- Gallium, Indium, and Thallium are considered to be transition metals

## Random Facts

- Boron is found in Borax (a water softener used in some laundry products) and Boric Acid (a mild antiseptic)
- Aluminum is the most abundant metal found in the Earth's crust
- Aluminum is strong and light and used in everything from soda cans to the frames of cars and airplanes



# The Carbon Group

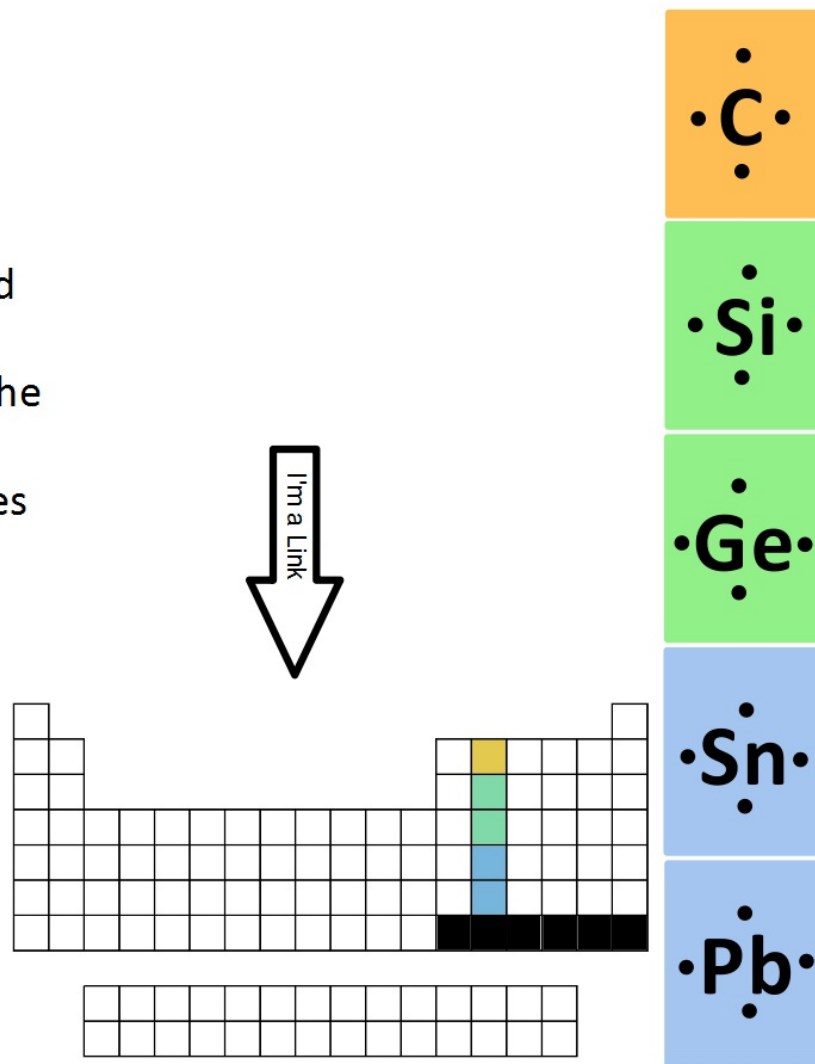
Oxidation #  $\rightarrow$  +/-4  
Roman Numeral  $\rightarrow$  IV  
Group #  $\rightarrow$  14

## Properties

- Each element Group 14 has 4 electrons in its outer shell, but that's where the similarities end.
- Carbon is a Nonmetal
- Silicon and Germanium are Metalloids
- Tin and Lead are Transition Metals

## Random Facts

- Many Carbon compounds are essential to life, and can be found all around you.
- **Allotropes**: are different molecular structures of the same compound
- Diamond and graphite are two different Allotropes of Carbon
- In the mid-1980's scientists discovered a 3rd Allotrope of Carbon, Buckyballs
- **Buckyballs** were used to construct microscopic tubes called nanotubes.
- Silicon is second only to Oxygen in abundance in Earth's crust
- Silicon is the main component in Semiconductors
- Tin can be combined with other metals to make Bronze and Pewter
- Lead is toxic but is still used in batteries



## The Nitrogen Group

### Properties

- Each element has 5 electrons in its outer shell
- These elements tend to share their electrons forming covalent compounds with other nonmetallic elements
- Nitrogen exists in nature as a diatomic molecule (N<sub>2</sub>)

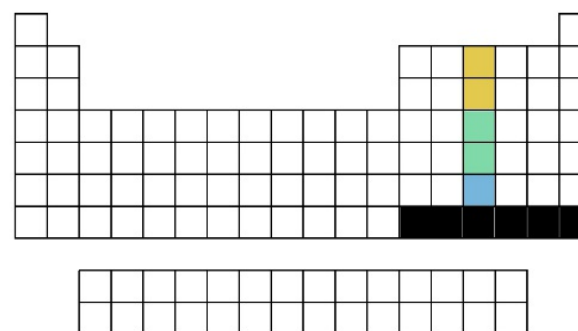
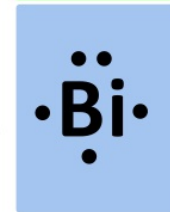
### Random Facts

- Nitrogen is the 4th most abundant element in your body
- Nitrogen compounds are used to make fertilizers
- Phosphorus can be used in several things from match heads to fertilizers
- Arsenic is toxic and really only used now for certain computer parts
- Bismuth and Antimony are used with other metals to lower their melting points

Oxidation # → 3-

Roman Numeral → V

Group # → 15



# The Oxygen Group

## Properties

- These elements have 6 electrons in their valence shell
- Oxygen exists in air as a diatomic molecule (O<sub>2</sub>)

## Random Facts

- Oxygen (O<sub>2</sub>) is need by almost all living things on Earth
- Sulfur exists as many different-shaped crystals and a non-crystalline form
- Sulfur combines with metals to form sulfides

Oxidation # → 2-

Roman Numeral → VI

Group # → 16

