

**Characteristics  
of  
Metals  
Metalloids  
&  
Nonmetals**

# Metals – Left of the stair steps

## Periodic Table of the Elements

Main groups										Main groups							
1 1A											13 3A	14 4A	15 5A	16 6A	17 7A	18 8A	
1 H 1.00794	2 2A	Transition metals										5 B 10.81	6 C 12.011	7 N 14.0067	8 O 15.9994	9 F 18.998403	10 Ne 20.1797
3 Li 6.941	4 Be 9.01218	3 3B	4 4B	5 5B	6 6B	7 7B	8 8B	9 8B	10 8B	11 1B	12 2B	13 Al 26.98154	14 Si 28.0855	15 P 30.97376	16 S 32.066	17 Cl 35.453	18 Ar 39.948
19 K 39.0983	20 Ca 40.078	21 Sc 44.9559	22 Ti 47.88	23 V 50.9415	24 Cr 51.996	25 Mn 54.9380	26 Fe 55.847	27 Co 58.9332	28 Ni 58.69	29 Cu 63.546	30 Zn 65.39	31 Ga 69.72	32 Ge 72.61	33 As 74.9216	34 Se 78.96	35 Br 79.904	36 Kr 83.80
37 Rb 85.4678	38 Sr 87.62	39 Y 88.9059	40 Zr 91.224	41 Nb 92.9064	42 Mo 95.94	43 Tc (98)	44 Ru 101.07	45 Rh 102.9055	46 Pd 106.42	47 Ag 107.8682	48 Cd 112.41	49 In 114.82	50 Sn 118.710	51 Sb 121.757	52 Te 127.60	53 I 126.9045	54 Xe 131.29
55 Cs 132.9054	56 Ba 137.33	57 *La 138.9055	72 Hf 178.49	73 Ta 180.9479	74 W 183.85	75 Re 186.207	76 Os 190.2	77 Ir 192.22	78 Pt 195.08	79 Au 196.9665	80 Hg 200.59	81 Tl 204.383	82 Pb 207.2	83 Bi 208.9804	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra 226.0254	89 †Ac 227.0278	104 Rf (261)	105 Db (262)	106 Sg (266)	107 Bh (264)	108 Hs (269)	109 Mt (268)	110 (271)	111 (272)	112 (277)		114 (289)		116 (289)		118 (293)

*Lanthanide series	58 Ce 140.12	59 Pr 140.9077	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.96	64 Gd 157.25	65 Tb 158.9254	66 Dy 162.50	67 Ho 164.9304	68 Er 167.26	69 Tm 168.9342	70 Yb 173.04	71 Lu 174.967
†Actinide series	90 Th 232.0381	91 Pa 231.0359	92 U 238.0289	93 Np 237.048	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (262)

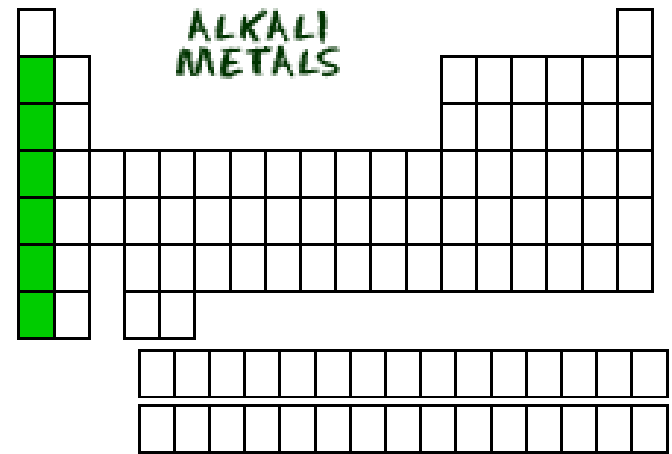
# Properties

- **Good conductors**
  - a. **Heat**
  - b. **Electricity**
- **Malleable – can be rolled into sheets**
- **Ductile – pulled into wires**
- **Usually shiny**
- **Generally have 3 or fewer electrons in their outer energy level**
- **Metals will hold together by sharing electrons evenly throughout (Metallic bonding)**
- **Lose electrons quite easily to form positive Ions**

# Alkali Metals

- **Group 1**
- **Characteristics**
  - **Soft**
  - **Most reactive of all metals**
    - **Reacts violently with Water**
  - **Never found free in nature**
  - **In pure form they must be kept under oil or they would react with oxygen in the air**
  - **Quickly give up outer electron to form an ion**

*What is a property of the alkali metals and how many electrons does it have in its outer energy level?\**



# Lithium

- **3 protons**
- **Used in:**
  - **alkaline batteries**
  - **Ceramics**
  - **glassmaking**
  - **fungicide**

*What are some uses of Lithium?\**

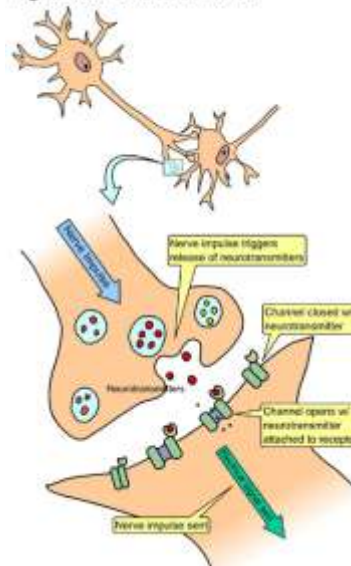


# Sodium

- 11 protons, abundant in earth's crust
- Reacts violently with water
- Uses:
  - Drain cleaner
    - Sodium hydroxide NaOH
  - Table salt NaCl
    - Nerve impulses
    - Fluid balance



Figure D-2: Neurotransmitters



*What is the most abundant metal in the earth's crust and how many electrons does it have in its outer level?\**

# Potassium

- **19 protons, abundant in the earth's crust**
- **Uses**
  - **Fertilizers – K is necessary for plant growth**
  - **$\text{KNO}_3$  – used in matches, gun powder, fireworks and other explosives**
    - **potassium nitrate 75%, sulphur 10 % and charcoal 15%**
  - **Potassium and sodium both help control the movement of liquids through the body and nerve impulses**



*What are some common uses of potassium?\**

# Other Alkaline Metals

- **Cesium & Rubidium – Light sensitive**
  - Used as photo electric cells
- **Francium – Radio active and very unstable.**
  - Flame Tests can be used to identify many of these elements.



# Alkaline Earth Metals

- **Group 2**
- **Characteristics**
  - Very reactive**
  - Not found free in nature**
  - Gives up electrons easily**
  - 2 electrons in the outer energy level**

		Be				
		Mg				
		Ca				
		Sr				
		Ba				
		Ra				

*How many electrons are found in the outer energy level of the alkaline earth metals?\**

# Elements

- **Beryllium – found in mineral beryl**
- **Magnesium**
  - 1) **Burns brightly**
  - 2) **Used in flash bulbs**
  - 3) **In chlorophyll**
  - 4) **Epson Salt  $\text{MgSO}_4$**
  - 5) **Stomach antacids  $\text{Mg}(\text{OH})_2$**



# **Other Alkalline earth metals**

- **Strontium – red in fireworks**
- **Barium – stored under oil**
  - 1) **Used to absorb Xray in digestive Xrays**
- **Radium – found in uranium ores**
  - 1) **Radio active**
  - 2) **Silvery white**
  - 3) **Used in cancer treatment**
  - 4) **Used in paint in the past to make glow in the dark paint**

From [1917](#) to [1926](#), U.S. Radium Corporation was engaged in the extraction and purification of [radium](#) from [carnotite](#) ore to produce [luminous paints](#), which were produced under the brand name '[Undark](#)'. As a [defense contractor](#), U.S. Radium was a major supplier of [radioluminescent](#) watches to the military. Their plant in [New Jersey](#) employed over a hundred workers, mainly women, to paint radium-lit watch faces and instruments.

### [\[edit\]](#) **Radiation exposure**

The Radium Girls saga holds an important place in the history of both the progression of the field of [health physics](#) and of the labor rights movement. The U.S. Radium Corporation hired some 70 women to perform various tasks including the handling of radium, while the owners and their scientists — familiar with the effects of radium — carefully avoided any exposure to themselves; chemists at the plant used lead screens, masks and tongs. An estimated 4,000 workers were hired by [corporations](#) in the US and [Canada](#) to paint watch faces with radium.

For fun, the Radium Girls painted their nails, teeth and faces with the deadly paint produced at the factory, sometimes to surprise their boyfriends when the lights went out. They mixed glue, water and radium powder, and then used [camel hair](#) brushes to apply the glowing paint onto dial numbers. The going rate, for painting 250 dials a day, was about a penny and a half per dial. The brushes would lose shape after a few strokes, so the U.S. Radium supervisors encouraged their workers to point the brushes with their lips, or use their tongues to keep them sharp.

### [\[edit\]](#) **Radiation sickness**

Many of the women later began to suffer from [anemia](#), bone fractures and [necrosis](#) of the jaw. Primitive [x-ray cameras](#) bombarded some of the sickened workers with additional radiation when they sought medical attention for the many ailments that ensued. It turned out at least one of the examinations was a ruse, part of a campaign of [disinformation](#) started by the defense contractor. U.S. Radium, like other watch-dial companies, rejected claims that the afflicted workers were suffering from exposure to radium. For some time, doctors, dentists, and researchers complied with requests from the companies not to release their data. At the urging of the companies, worker deaths were attributed by medical professionals to other causes; [syphilis](#) was often cited in attempts to smear the reputations of the women.

# Transition Elements

- **Elements 3-12**
  - Usually 1-3 electrons in their outer energy level
  - High melting points and are hard
  - Elements usually have distinct color
  - Good conductors of heat and electricity

A periodic table of elements with the transition metals highlighted in red and yellow. The red elements are in groups 1 and 2 (IA and IIA) and groups 8, 9, and 10 (VIII, VIII, and VIII). The yellow elements are in groups 3 through 7 (IIIB, IVB, VB, VIB, and VIIB). The lanthanide and actinide series are shown in orange at the bottom.

1 IA	2 IIA											13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 VIIIA	
H	He											B	C	N	O	F	Ne	
Li	Be											Al	Si	P	S	Cl	Ar	
Na	Mg	3 IIIB	4 IVB	5 VB	6 VIB	7 VIIB	8 VIII	9 VIII	10 VIII	11 IB	12 IIB	Zn	Ga	Ge	As	Se	Br	Kr
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu								
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe	
Cs	Ba		Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn	
Fr	Ra		Unq	Unp	Unh	Uns	Uno	Une										
		La Ce Pr Nd Pm Sm Eu Gd Tb Dy Ho Er Tm Yb Lu																
		Ac Th Pa U Np Pu Am Cm Bk Cf Es Fm Md No Lr																

# Lanthanides and Actinides

- **Originally thought to be rare in nature**
- **Monazite – a mineral that contains all the lanthanides but one**
- **Make up 25% of metals in earth's crust**
- **Actinides and Lanthanides closely resemble each other in electron arrangements**
- **Uses**
  - a. Used to give television bright color**
  - b. Optic fibers**
  - c. Polish and abrasives**

# Metalloids

- substance that exhibit some but not all of the properties of metals
- uses
  - a. Semiconductors
  - b. Photoconductors
  - c. Glass  $\text{SiO}_2$
  - d. Transistors

	1A	2A											3A	4A	5A	6A	7A	8A
1	H																	He
2	Li	Be											B	C	N	O	F	Ne
3	Na	Mg	3B	4B	5B	6B	7B	8B			1B	2B	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	Ac†	Rf	Db	Sg	Bh	Hs	Mt	**	**	**						
*Lanthanide series			Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu		
†Actinide series			Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr		

\*\* Not yet named

# Boron Family

- **Boron is a metalloid but all others of this family are metals**
- **Boron is used in glassware and bleaches**
- **Aluminum – light strong metal with many uses**
  - **Most abundant metal on earth**
  - **Refined from the ore bauxite**





# **Alloys – Mixture of metals to produce desired properties**

- **Steel – iron mixed with carbon**
- **Stainless steel – chromium and steel**
- **Solder is lead and tin**



# **Nitrogen family – group 15**

- **Nitrogen family contains metals, metalloids and nonmetals**
- **Nitrogen is the most abundant gas in the atmosphere**
  - a. As a gas it is diatomic  $N_2$**
  - b. Important part of fertilizers**
  - c. Used in explosives**

# Phosphorus

- **Two major forms of allotropes**
- **White and Red**
  - **White reacts violently with  $O_2$**
  - 3) Used in fertilizers**
  - 4) Detergents**



# Arsenic

- **Used in poison**
- **Used to make transistors**



# **Bismuth**

- **Used mostly as an alloy**
- **Used in fire sprinkler systems**

# Oxygen Family

- **6 electrons in the outer energy level**
  - **oxygen is the most abundant element on earth**
    - **Several allotropes of oxygen**
      - **O<sub>2</sub> Like we breath**
      - **O<sub>3</sub> Ozone that shield out ultra violet rays**
    - **Sulfur**
      - **Often found in coal as unwanted element**
      - **Sulfuric acid used in industry**
      - **Used in gun powder**
    - **Tellurium – exception to Mendeleev's order by mass**
      - **Used in alloys to improve corrosion resistance**
    - **Polonium**
      - **Found in uranium ore**
      - **Very radio active**

# Halogen Family

- **Group 17**
- **seven electrons in the outer energy level**
- **Halogen means salt producer**
- **Combines with metals to form salts**
- **form ionic bonds with metals**
- **Diatomic examples are  $F_2$ ,  $Cl_2$**



# Halogens

- **Fluorine**
  - a. **Used in nonstick cookware**
  - b. **Blood substitutes**
  - c. **Tooth paste**
- **Chlorine**
  - a. **Cleaning fluids**
  - b. **Disinfectants**
  - c. **Metal cleaners**
  - d. **Gastric (stomach) Juices**

# Halogens

- **Bromine**
  - **Dyes**
  - **Insect control**
  - **Flame retardant**
- **Iodine**
  - **Crystal solid are room temperature**
  - **Tincture of iodine used in medicine as and antiseptic**
  - **Needed in the body for growth**
- **Astatine** –
  - **Rare and radio active**
  - **Found in uranium ores**

# Noble Gases

- once called inert gases
- All but helium have 8 electrons in their outer energy level
- **Helium**
  - Used in balloons
  - Used to decrease decompression sickness
- **Neon**
  - Lights
- **Argon**
  - Lights
  - Welding
- **Radon**
  - Used in cancer treatment
  - Is a gas that comes out of the ground from the break down of uranium and will build up in houses