

## Chapter 5

### The Periodic Table

Organizing the Elements

The Modern Periodic Table

Representative Groups

# Periodic Table of Elements

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## Periodic Table Focus Points

- Explain the history of the Periodic Table including the scientists who contributed to it (Mendeleev, Moseley).
- Describe the arrangement of the periodic table (periods, groups, periodic law, classes of elements) and its components (atomic mass, atomic number, element symbols).
- Classify elements into representative groups based on electron configuration for Valence (outer electrons that bond).



But there were some substances that you couldn't break down into anything else.

These are the chemical *elements*.

Observe the items in all 24 squares below looking for similar characteristics.

Consider how to organize the items based on recognizable & sensible patterns.

Meat radio	Seafood microwave	Soup infrared	Dairy Visible ROY	Breads Visible GBIV	Vegetables ultraviolet	Pasta x-rays	Fruit gamma
Pork 0.5 lb radio	Salmon steak microwave	Beans 5 pods ultraviolet	Milk 1 gallon visible ROY	Grapes 1 twig gamma	Beef 0.25 lb radio	Tomato Soup 8 oz infrared	Rye 1 loaf visible GBIV
Stew 32 oz infrared	Spaghetti 1 pot x-rays	Bananas 1 bunch gamma	Clams 1 bushel microwave	Cheese 1 slice visible ROY	Celery 1 stalk ultraviolet	Eggs 1 dozen visible ROY	Barley 1 stalk visible GBIV
Chicken Noodle 16 oz infrared	Wheat flour 2 lbs visible GBIV	Shrimp Cocktail microwave	Rigatoni 1 bite x-rays	Chicken 1 lb radio	Apple 1 bushel gamma	Cucumber 1 plant ultraviolet	Macaroni 1 bowl x-rays

# Periodic Table of Foods

Meat radio	Seafood microwave	Soup infrared	Dairy Visible ROY	Breads Visible GBIV	Vegetables ultraviolet	Pasta x-rays	Fruit gamma
Beef 0.25 lb	Shrimp cocktail	Tomato Soup 8 oz	Cheese 1 slice	Rye 1 loaf	Beans 5 pods	Rigatoni 1 bite	Grapes 1 twig
<b>Pork</b> 0.5 lb	Salmon steak	Chicken Noodle 16 oz	Eggs 1 dozen	Barley 1 stalk	Cucumber 1 plant	Macaroni 1 bowl	Bananas 1 bunch
Chicken 1.0 lb	Clams 1 bushel	Stew 32 oz	Milk 1 gallon	Wheat flour 2 lbs	Celery 1 stalk	Spaghetti 1 pot	Apple 1 bushel

What guidelines did you use to make your Periodic Table of Foods? How did you determine “Groups”?

How did you determine “Periods” or “Rows”?

# Periodic Table of Foods

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What guidelines did you use to make your Periodic Table of Foods? How did you determine “Groups”?

*Food groups & EM radiation order*

How did you determine “Periods” or “Rows”?

*Amounts within each food group*



# How was the periodic table developed and how is it arranged?

Reihen	Gruppe I. — R <sup>0</sup>	Gruppe II. — RO	Gruppe III. — R <sup>0</sup> '	Gruppe IV. RH <sup>4</sup> RO <sup>2</sup>	Gruppe V. RH <sup>5</sup> R <sup>0</sup> ''	Gruppe VI. RH <sup>6</sup> RO <sup>3</sup>	Gruppe VII. RH R <sup>0</sup> '	Gruppe VIII. — RO <sup>4</sup>
1	H=1							
2	Li=7	Be=9,4	B=11	C=12	N=14	O=16	F=19	
3	Na=23	Mg=24	Al=27,3	Si=28	P=31	S=32	Cl=35,5	
4	K=39	Ca=40	—=44	Ti=48	V=51	Cr=52	Mn=55	Fe=56, Co=59, Ni=59, Cu=63.
5	(Cu=63)	Zn=65	—=68	—=72	As=75	Se=78	Br=80	
6	Rb=85	Sr=87	?Yt=88	Zr=90	Nb=94	Mo=96	—=100	Ru=104, Rh=104, Pd=106, Ag=108.
7	(Ag=108)	Cd=112	In=113	Sn=118	Sb=122	Te=125	J=127	
8	Cs=133	Ba=137	?Di=138	?Ce=140	—	—	—	— — — —
9	(—)	—	—	—	—	—	—	
10	—	—	?Er=178	?La=180	Ta=182	W=184	—	Os=195, Ir=197, Pt=198, Au=199.
11	(Au=199)	Hg=200	Tl=204	Pb=207	Bi=208	—	—	
12	—	—	—	Th=231	—	U=240	—	— — — —

# Enrichment

## Searching for an Organizing Principle

In 1829, a German chemist, J. W. **Dobereiner**, published a classification system. He grouped known elements into **triads**, sets of three elements with **similar properties**.

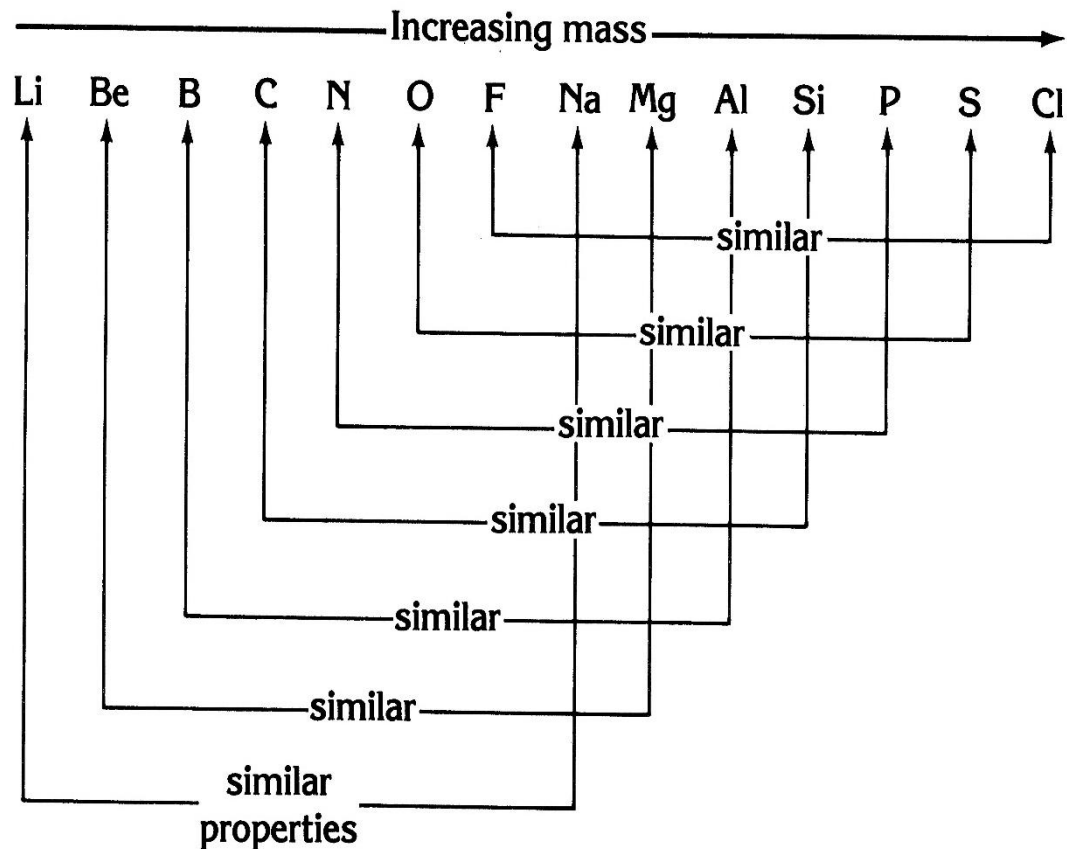




### John Newlands (1865)

He arranged the Periodic Table according to increasing atomic mass. *He established the “Law of Octaves.”*

*Newlands noticed a repeating pattern of **similar properties** every **eight** elements on the Periodic table.*



## Mendeleev's Periodic Table

In 1869, the Russian chemist Dmitri **Mendeleev** produced the first orderly arrangement, or periodic table, of all 63 elements known at the time.



# Mendeleev's Periodic Table



- Mendeleev arranged the elements in order of **increasing atomic mass**.
- Mendeleev used element symbols and aligned them based on a set of **physical** and **chemical properties** that repeat from row to row.

Group I	Group II	Group III	Group IV	Group V	Group VI	Group VII	Group VIII
H = 1							
Li = 7	Be = 9.4	B = 11	C = 12	N = 14	O = 16	F = 19	
Na = 23	Mg = 24	Al = 27.3	Si = 28	P = 31	S = 32	Cl = 35.5	Fe = 56, Co = 59, Ni = 59, Cu = 63.
K = 39	Ca = 40	— = 44	Ti = 48	V = 51	Cr = 52	Mn = 55	
(Cu = 63)	Zn = 65	— = 68	— = 72	As = 75	Se = 78	Br = 80	Ru = 104, Rh = 104, Pd = 106, Ag = 108.
Rb = 85	Sr = 87	Yt = 88	Zr = 90	Nb = 94	Mo = 96	— = 100	
(Ag = 108)	Cd = 112	In = 113	Sn = 118	Sb = 122	Te = 125	I = 127	
Cs = 133	Ba = 137	Di = 138	Ce = 140	—	—	—	— — — —
(—)	—	—	—	—	—	—	
—	—	Er = 178	La = 180	Ta = 182	W = 184	—	Os = 195, Ir = 197, Pt = 198, Au = 199.
(Au = 199)	Hg = 200	Tl = 204	Pb = 207	Bi = 208	—	—	
—	—	—	Th = 231	—	U = 240	—	

# Mendeleev's Periodic Table

Mendeleev noticed that **similar properties** of elements occurred after “**periods**” of varying lengths (**rows** on Periodic Table).

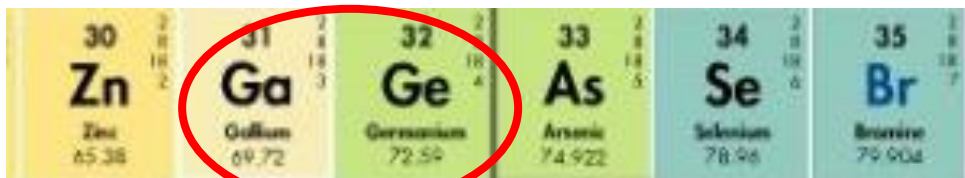
He established “**Families**” or “**Groups**” (*columns*) on the Periodic Table, possessing **similar chemical properties**.



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Na = 23 K = 39	Mg = 24 Ca = 40	Al = 27.3 — = 44	Si = 28 Ti = 48	P = 31 V = 51	S = 32 Cr = 52	Cl = 35.5 Mn = 55	Fe = 56, Co = 59, Ni = 59, Cu = 63.
(Cu = 63) Rb = 85	Zn = 65 Sr = 87	— = 68 Yt = 88	— = 72 Zr = 90	As = 75 Nb = 94	Se = 78 Mo = 96	Br = 80 — = 100	Ru = 104, Rh = 104, Pd = 106, Ag = 108.
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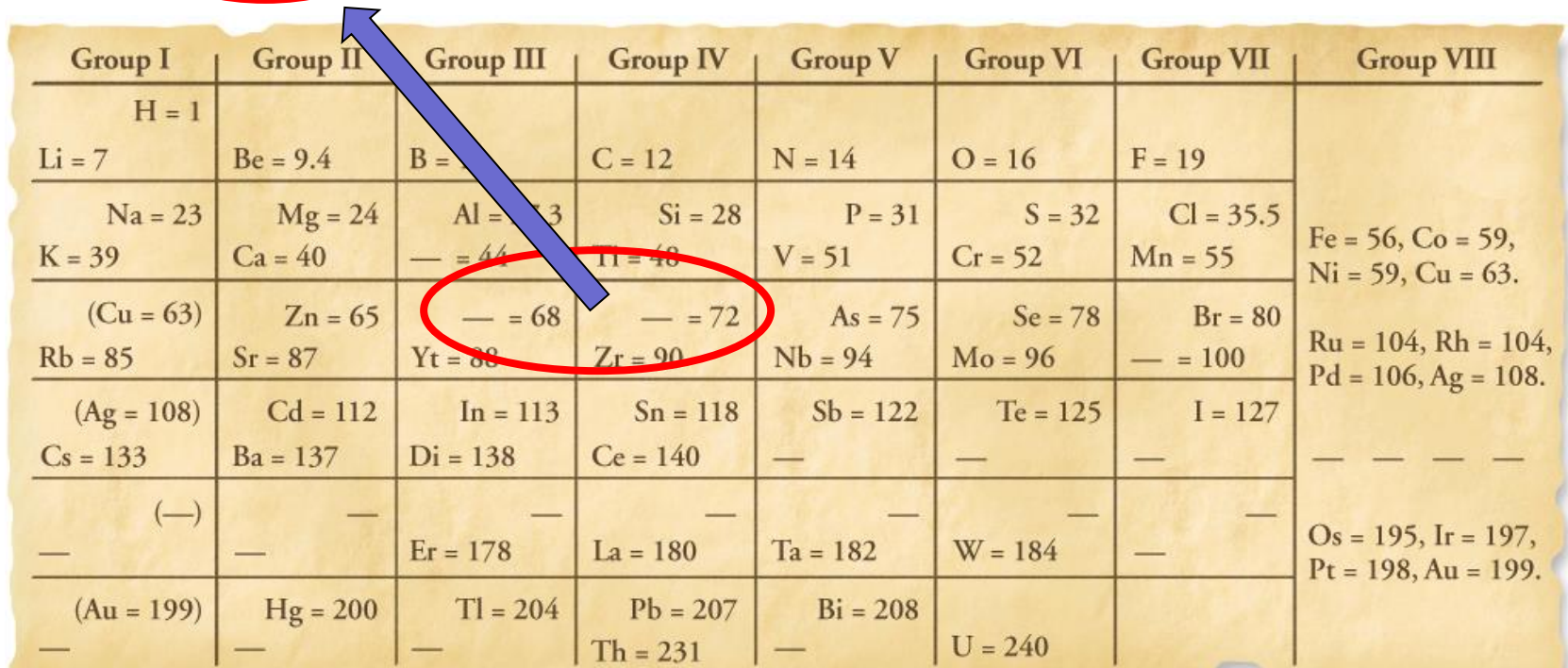
# Mendeleev's Periodic Table

Mendeleev **predicted** properties and masses of **unknown elements** that he knew existed. (e.g. scandium, gallium, germanium).



30 Zn Zinc 65.38	31 Ga Gallium 69.72	32 Ge Germanium 72.59	33 As Arsenic 74.922	34 Se Selenium 78.96	35 Br Bromine 79.904
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*Notice the blanks on the Periodic Table.*



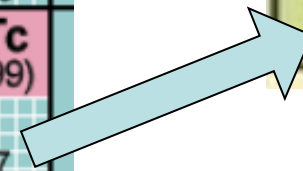
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—	—	—	Th = 231	—	U = 240	—	

# Mendeleev's Periodic Table

Mendeleev could NOT account for **Iodine** whose atomic mass was less than Tellurium, but whose chemical properties belonged with Br and Cl's group.

0	I	II	III	IV	V	VI	VII
He 4.00	Li 6.94	Be 9.01	B 10.8	● C 12.0	N 14.0	O 16.0	F 19.0
Ne 20.2	Na 23.0	Mg 24.3	Al 27.0	Si 28.1	P 31.0	● S 32.1	Cl 35.5
● Ar 40.0	● K 39.1	Ca 40.1	Sc 45.0	Ti 47.9	V 50.9	Cr 52.0	Mn 54.9
Kr 83.8	● Rb 85.5	Sr 87.6	Y 88.9	Zr 91.2	Nb 92.9	Mo 95.9	Tc (99)
Xe 131	● Ce 133	Ba 137	● La 139	Hf 179	Ta 181	● W 184	Re 180
	● Au 197	● Hg 201	Ti 204	● Pb 207	Bi 209	Po (210)	At (210)

8 O Oxygen 15.999	9 F Fluorine 18.998
16 S Sulfur 32.06	17 Cl Chlorine 35.453
34 Se Selenium 78.96	35 Br Bromine 79.904
52 Te Tellurium 127.60	53 I Iodine 126.90



# The Modern Periodic Table

- **Henry Moseley** (1887-1915) discovered that major properties of an element are determined by **atomic number**, not atomic weight.
- After the discovery of protons, the periodic table was arranged in order of **increasing atomic number**.
- Mendeleev did not account for variations resulting from isotopes.



# The Modern Periodic Table

The **periodic table** of elements is an organized display of the chemical elements.

- In order of increasing atomic number (protons)
- Based on similar chemical properties
- ❖ Based on similar electron configurations

## Periodic Table of Elements

Click an element's box for more info.

Element Class    State of Matter    Orbitals (SPDF)

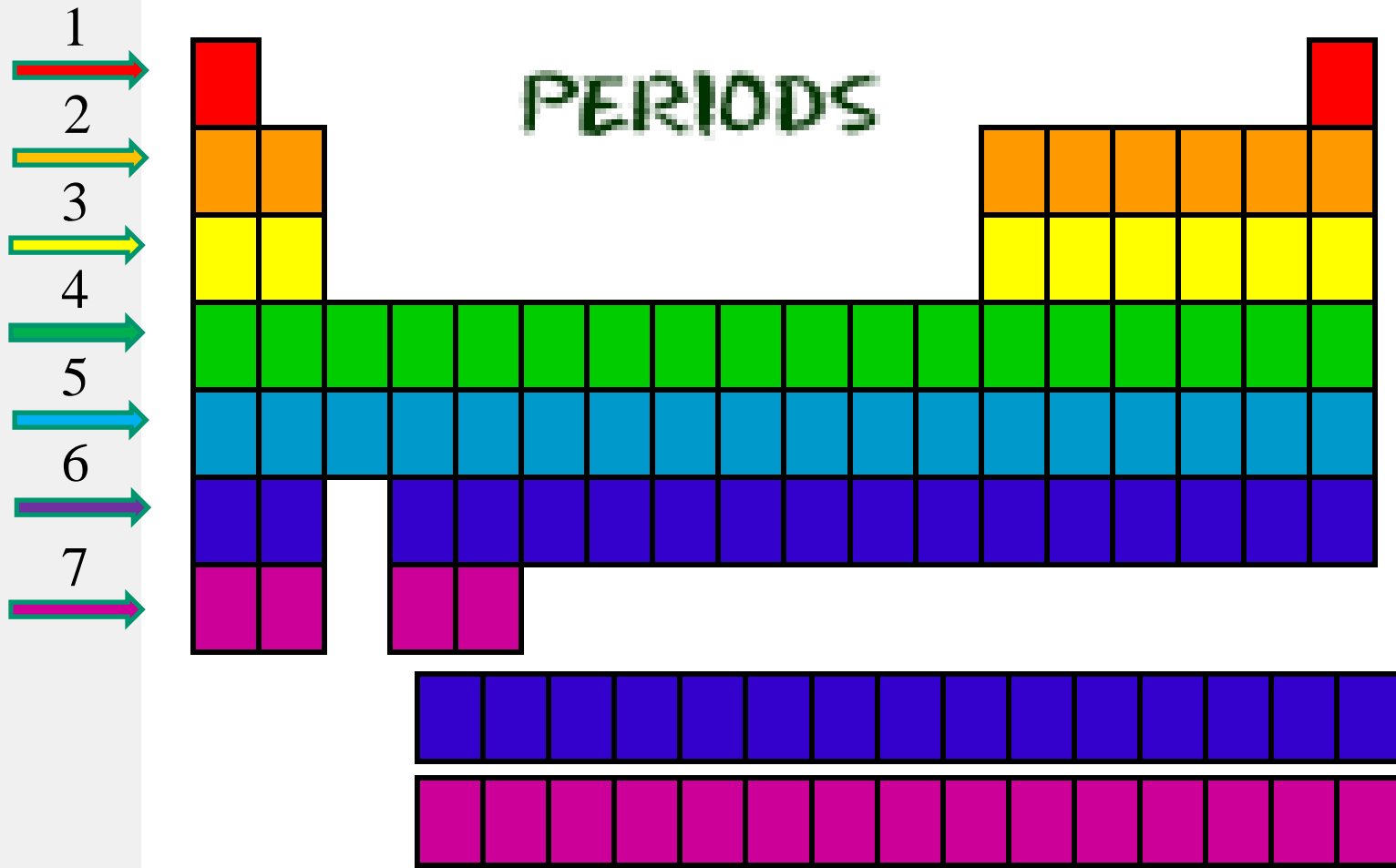
<div style="display: flex; justify-content: space-between;"> <div style="border: 1px solid black; padding: 5px; width: 20%;"> <p>Atomic Number <b>1</b></p> <p><b>H</b></p> <p>Hydrogen</p> <p>(Ave) Atomic Mass 1.01</p> </div> <div style="width: 30%;"> <p>Non-Metal</p> <p>Semi-Metal</p> <p>Halogen</p> <p>Noble Gas</p> <p>Lanthanide</p> </div> <div style="width: 30%;"> <p>Alkali Metal</p> <p>Alkaline Earth Metal</p> <p>Transition Metal</p> <p>Post-Transition Metal</p> <p>Actinide</p> </div> </div>																																															
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11 Na Sodium 22.99	12 Mg Magnesium 24.31																	13 Al Aluminum 26.98	14 Si Silicon 28.09	15 P Phosphorus 30.97	16 S Sulfur 32.07	17 Cl Chlorine 35.45	18 Ar Argon 39.95																								
19 K Potassium 39.10	20 Ca Calcium 40.08	21 Sc Scandium 44.96	22 Ti Titanium 47.87	23 V Vanadium 50.94	24 Cr Chromium 52.00	25 Mn Manganese 54.94	26 Fe Iron 55.85	27 Co Cobalt 58.93	28 Ni Nickel 58.69	29 Cu Copper 63.55	30 Zn Zinc 65.39	31 Ga Gallium 69.72	32 Ge Germanium 72.61	33 As Arsenic 74.92	34 Se Selenium 78.96	35 Br Bromine 79.90	36 Kr Krypton 83.80																														
37 Rb Rubidium 85.47	38 Sr Strontium 87.62	39 Y Yttrium 88.91	40 Zr Zirconium 91.22	41 Nb Niobium 92.91	42 Mo Molybdenum 95.94	43 Tc Technetium 98.00	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.91	46 Pd Palladium 106.42	47 Ag Silver 107.87	48 Cd Cadmium 112.41	49 In Indium 114.82	50 Sn Tin 118.71	51 Sb Antimony 121.76	52 Te Tellurium 127.60	53 I Iodine 126.90	54 Xe Xenon 131.29																														
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87 Fr Francium 223.00	88 Ra Radium 226.00	89 - 103		104 Rf Rutherfordium 261.00	105 Db Dubnium 262.00	106 Sg Seaborgium 266.00	107 Bh Bohrium 264.00	108 Hs Hassium 277.00	109 Mt Meitnerium 268.00	110 Ds Darmstadtium 281.00	111 Rg Roentgenium 272.00	112 Cn Copernicium 285.00	113 Uut Ununtrium 284.00	114 Fl Flerovium 289.00	115 Uup Ununpentium 288.00	116 Lv Livermorium 291.00	117 Uus Ununseptium Unknown	118 Uuo Ununoctium 294.00																													
<table border="1" style="width: 100%; text-align: center;"> <tr> <td>57 La Lanthanum 138.91</td> <td>58 Ce Cerium 140.12</td> <td>59 Pr Praseodymium 140.91</td> <td>60 Nd Neodymium 144.24</td> <td>61 Pm Promethium 145.00</td> <td>62 Sm Samarium 150.36</td> <td>63 Eu Europium 151.97</td> <td>64 Gd Gadolinium 157.25</td> <td>65 Tb Terbium 158.93</td> <td>66 Dy Dysprosium 162.50</td> <td>67 Ho Holmium 164.93</td> <td>68 Er Erbium 167.26</td> <td>69 Tm Thulium 168.93</td> <td>70 Yb Ytterbium 173.04</td> <td>71 Lu Lutetium 174.97</td> </tr> <tr> <td>89 Ac Actinium 227.00</td> <td>90 Th Thorium 232.04</td> <td>91 Pa Protactinium 231.04</td> <td>92 U Uranium 238.03</td> <td>93 Np Neptunium 237.00</td> <td>94 Pu Plutonium 244.00</td> <td>95 Am Americium 243.00</td> <td>96 Cm Curium 247.00</td> <td>97 Bk Berkelium 247.00</td> <td>98 Cf Californium 251.00</td> <td>99 Es Einsteinium 252.00</td> <td>100 Fm Fermium 257.00</td> <td>101 Md Mendelevium 258.00</td> <td>102 No Nobelium 259.00</td> <td>103 Lr Lawrencium 262.00</td> </tr> </table>																		57 La Lanthanum 138.91	58 Ce Cerium 140.12	59 Pr Praseodymium 140.91	60 Nd Neodymium 144.24	61 Pm Promethium 145.00	62 Sm Samarium 150.36	63 Eu Europium 151.97	64 Gd Gadolinium 157.25	65 Tb Terbium 158.93	66 Dy Dysprosium 162.50	67 Ho Holmium 164.93	68 Er Erbium 167.26	69 Tm Thulium 168.93	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.97	89 Ac Actinium 227.00	90 Th Thorium 232.04	91 Pa Protactinium 231.04	92 U Uranium 238.03	93 Np Neptunium 237.00	94 Pu Plutonium 244.00	95 Am Americium 243.00	96 Cm Curium 247.00	97 Bk Berkelium 247.00	98 Cf Californium 251.00	99 Es Einsteinium 252.00	100 Fm Fermium 257.00	101 Md Mendelevium 258.00	102 No Nobelium 259.00	103 Lr Lawrencium 262.00
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1. In Mendeleev's periodic table, elements with similar properties were grouped
  - a. in the same row.
  - b. in the same column.
  - c. in diagonal lines that run from top left to the bottom right.
  - d. in pairs of two.
  
2. For which element did Mendeleev correctly predict the properties even before it had been discovered?
  - a. gallium
  - b. hydrogen
  - c. bromine
  - d. Aluminum
  
3. In the modern periodic table, elements are arranged in order of increasing atomic \_\_\_\_\_.

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3. In the modern periodic table, elements are arranged in order of increasing atomic **number (protons)**.

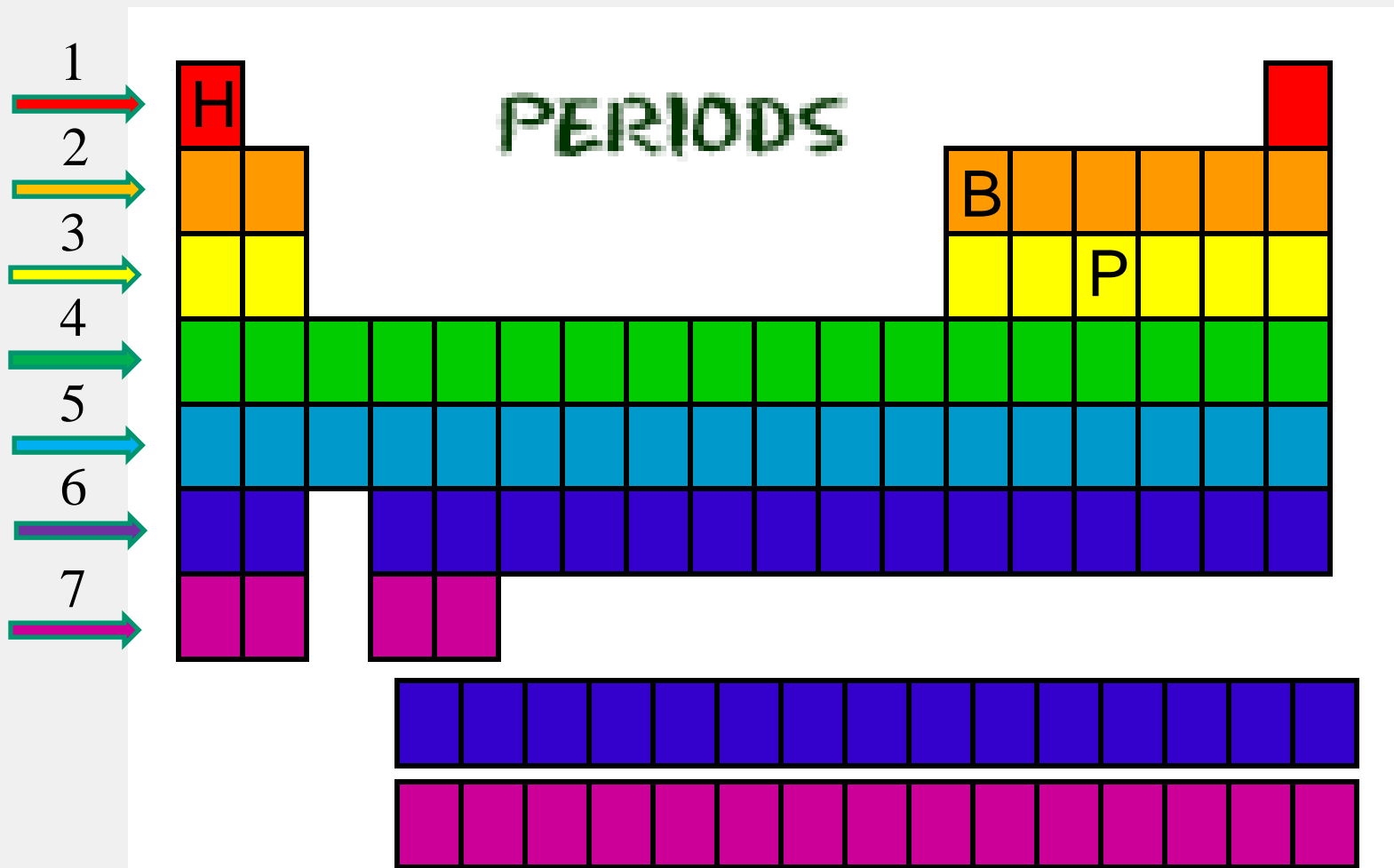
Bohr used the **ROWS** or **PERIODS** on the periodic table to represent the **energy levels** in an atom.



Hydrogen, H, (period 1) has an electron in energy level 1.

Boron, B, (period 2), has 3 electrons in its **second** energy level.

Phosphorus, P, (period 3), has 5 electrons in its **third** energy level.



# Periods

**Period:** a horizontal **row** on the periodic table.

- Atomic number increases from left to right across the period.
- Chemical properties change systematically across the periodic table creating **“periodic law”**.

1 H Hydrogen 1.01																	2 He Helium 4.00																
3 Li Lithium 6.94	4 Be Beryllium 9.01											5 B Boron 10.81	6 C Carbon 12.01	7 N Nitrogen 14.01	8 O Oxygen 16.00	9 F Fluorine 19.00	10 Ne Neon 20.18																
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# Groups or Families

Groups are the **columns** on the periodic table; also known as **families**.

- Elements within a group have **similar chemical properties**.

The image shows a periodic table with four vertical arrows pointing to specific groups. The first arrow on the far left points to Group 1 (Hydrogen). The second arrow on the far right points to Group 2 (Helium). The third arrow, located in the middle of the table, points to Group 13 (Boron). The fourth arrow, located on the right side of the table, points to Group 17 (Halogens). The elements in these groups are highlighted in various colors: Group 1 (blue), Group 2 (light blue), Group 13 (orange), and Group 17 (green).

1 H Hydrogen 1.01	2 He Helium 4.00											3 Li Lithium 6.94	4 Be Beryllium 9.01	5 B Boron 10.81	6 C Carbon 12.01	7 N Nitrogen 14.01	8 O Oxygen 16.00	9 F Fluorine 19.00	10 Ne Neon 20.18	11 Na Sodium 22.99	12 Mg Magnesium 24.31	13 Al Aluminum 26.98	14 Si Silicon 28.09	15 P Phosphorus 30.97	16 S Sulfur 32.07	17 Cl Chlorine 35.45	18 Ar Argon 39.95	19 K Potassium 39.10	20 Ca Calcium 40.08	21 Sc Scandium 44.96	22 Ti Titanium 47.87	23 V Vanadium 50.94	24 Cr Chromium 52.00	25 Mn Manganese 54.94	26 Fe Iron 55.85	27 Co Cobalt 58.93	28 Ni Nickel 58.69	29 Cu Copper 63.55	30 Zn Zinc 65.39	31 Ga Gallium 69.72	32 Ge Germanium 72.61	33 As Arsenic 74.92	34 Se Selenium 78.96	35 Br Bromine 79.90	36 Kr Krypton 83.80	37 Rb Rubidium 85.47	38 Sr Strontium 87.62	39 Y Yttrium 88.91	40 Zr Zirconium 91.22	41 Nb Niobium 92.91	42 Mo Molybdenum 95.94	43 Tc Technetium 98.00	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.91	46 Pd Palladium 106.42	47 Ag Silver 107.87	48 Cd Cadmium 112.41	49 In Indium 114.82	50 Sn Tin 118.71	51 Sb Antimony 121.76	52 Te Tellurium 127.60	53 I Iodine 126.90	54 Xe Xenon 131.29	55 Cs Cesium 132.91	56 Ba Barium 137.33	57-71 Lanthanides	72 Hf Hafnium 178.49	73 Ta Tantalum 180.95	74 W Tungsten 183.84	75 Re Rhenium 186.21	76 Os Osmium 190.23	77 Ir Iridium 192.22	78 Pt Platinum 195.08	79 Au Gold 196.97	80 Hg Mercury 200.59	81 Tl Thallium 204.38	82 Pb Lead 207.20	83 Bi Bismuth 208.98	84 Po Polonium 209	85 At Astatine 210	86 Rn Radon 222	87 Fr Francium 223	88 Ra Radium 226	89-103 Actinides	104 Rf Rutherfordium 261	105 Db Dubnium 262	106 Sg Seaborgium 266	107 Bh Bohrium 264	108 Hs Hassium 277	109 Mt Meitnerium 268	110 Ds Darmstadtium 281	111 Rg Roentgenium 272	112 Cn Copernicium 285	113 Uut Ununtrium 284	114 Fl Flerovium 289	115 Uup Ununpentium 288	116 Lv Livermorium 291	117 Uus Ununseptium Unknown	118 Uuo Ununoctium 294	119 Uuh Ununhennium Unknown	120 Uuq Ununquadium Unknown	121 Uuq Ununquadium Unknown	122 Uuq Ununquadium Unknown	123 Uuq Ununquadium Unknown	124 Uuq Ununquadium Unknown	125 Uuq Ununquadium Unknown	126 Uuq Ununquadium Unknown	127 Uuq Ununquadium Unknown	128 Uuq Ununquadium Unknown	129 Uuq Ununquadium Unknown	130 Uuq Ununquadium Unknown	131 Uuq Ununquadium Unknown	132 Uuq Ununquadium Unknown	133 Uuq Ununquadium Unknown	134 Uuq Ununquadium Unknown	135 Uuq Ununquadium Unknown	136 Uuq Ununquadium Unknown	137 Uuq Ununquadium Unknown	138 Uuq Ununquadium Unknown	139 Uuq Ununquadium Unknown	140 Uuq Ununquadium Unknown	141 Uuq Ununquadium Unknown	142 Uuq Ununquadium Unknown	143 Uuq Ununquadium Unknown	144 Uuq Ununquadium Unknown	145 Uuq Ununquadium Unknown	146 Uuq Ununquadium Unknown	147 Uuq Ununquadium Unknown	148 Uuq Ununquadium Unknown	149 Uuq Ununquadium Unknown	150 Uuq Ununquadium Unknown	151 Uuq Ununquadium Unknown	152 Uuq Ununquadium Unknown	153 Uuq Ununquadium Unknown	154 Uuq Ununquadium Unknown	155 Uuq Ununquadium Unknown	156 Uuq Ununquadium Unknown	157 Uuq Ununquadium Unknown	158 Uuq Ununquadium Unknown	159 Uuq Ununquadium Unknown	160 Uuq 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# Periodic Table with Atomic Numbers & Atomic Masses

The top number in each cell is the atomic number (protons).

- The bottom number in each cell is the average atomic weight.

1 H Hydrogen 1.01																	2 He Helium 4.00				
3 Li Lithium 6.94	4 Be Beryllium 9.01															5 B Boron 10.81	6 C Carbon 12.01	7 N Nitrogen 14.01	8 O Oxygen 16.00	9 F Fluorine 19.00	10 Ne Neon 20.18
11 Na Sodium 22.99	12 Mg Magnesium 24.31															13 Al Aluminum 26.98	14 Si Silicon 28.09	15 P Phosphorus 30.97	16 S Sulfur 32.07	17 Cl Chlorine 35.45	18 Ar Argon 39.95
19 K Potassium 39.10	20 Ca Calcium 40.08	21 Sc Scandium 44.96	22 Ti Titanium 47.87	23 V Vanadium 50.94	24 Cr Chromium 52.00	25 Mn Manganese 54.94	26 Fe Iron 55.85	27 Co Cobalt 58.93	28 Ni Nickel 58.69	29 Cu Copper 63.55	30 Zn Zinc 65.39	31 Ga Gallium 69.72	32 Ge Germanium 72.61	33 As Arsenic 74.92	34 Se Selenium 78.96	35 Br Bromine 79.90	36 Kr Krypton 83.80				
37 Rb Rubidium 85.47	38 Sr Strontium 87.62	39 Y Yttrium 88.91	40 Zr Zirconium 91.22	41 Nb Niobium 92.91	42 Mo Molybdenum 95.94	43 Tc Technetium 98.00	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.91	46 Pd Palladium 106.42	47 Ag Silver 107.87	48 Cd Cadmium 112.41	49 In Indium 114.82	50 Sn Tin 118.71	51 Sb Antimony 121.76	52 Te Tellurium 127.60	53 I Iodine 126.90	54 Xe Xenon 131.29				
55 Cs Cesium 132.91	56 Ba Barium 137.33	57 - 71	72 Hf Hafnium 178.49	73 Ta Tantalum 180.95	74 W Tungsten 183.84	75 Re Rhenium 186.21	76 Os Osmium 190.23	77 Ir Iridium 192.22	78 Pt Platinum 195.08	79 Au Gold 196.97	80 Hg Mercury 200.59	81 Tl Thallium 204.38	82 Pb Lead 207.20	83 Bi Bismuth 208.98	84 Po Polonium 208.98	85 At Astatine 209.99	86 Rn Radon 222.02				
87 Fr Francium 223.00	88 Ra Radium 226.00	89 - 103	104 Rf Rutherfordium 261.00	105 Db Dubnium 262.00	106 Sg Seaborgium 266.00	107 Bh Bohrium 264.00	108 Hs Hassium 277.00	109 Mt Meitnerium 268.00	110 Ds Darmstadtium 281.00	111 Rg Roentgenium 272.00	112 Cn Copernicium 285.00	113 Uut Ununtrium 284.00	114 Fl Flerovium 289.00	115 Uup Ununpentium 288.00	116 Lv Livermorium 291.00	117 Uus Ununseptium Unknown	118 Uuo Ununoctium 294.00				
			57 La Lanthanum 138.91	58 Ce Cerium 140.12	59 Pr Praseodymium 140.91	60 Nd Neodymium 144.24	61 Pm Promethium 145.00	62 Sm Samarium 150.36	63 Eu Europium 151.97	64 Gd Gadolinium 157.25	65 Tb Terbium 158.93	66 Dy Dysprosium 162.50	67 Ho Holmium 164.93	68 Er Erbium 167.26	69 Tm Thulium 168.93	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.97				
			89 Ac Actinium 227.00	90 Th Thorium 232.04	91 Pa Protactinium 231.04	92 U Uranium 238.03	93 Np Neptunium 237.00	94 Pu Plutonium 244.00	95 Am Americium 243.00	96 Cm Curium 247.00	97 Bk Berkelium 247.00	98 Cf Californium 251.00	99 Es Einsteinium 252.00	100 Fm Fermium 257.00	101 Md Mendelevium 258.00	102 No Nobelium 259.00	103 Lr Lawrencium 262.00				

Atomic mass is a value that depends on the distribution of an element's **isotopes** in nature and the masses of those isotopes.

- Atomic mass is given in atomic mass units (amu) which are defined as one twelfth the mass of a carbon-12 atom.
- The value of the atomic mass (e.g. chlorine) is a weighted average.

Distribution of Chlorine Isotopes in Nature		
Isotope	Percentage	Atomic Mass
Chlorine-35	75.78%	34.969
Chlorine-37	24.22%	36.966



The periodic table classifies elements in three ways:

1) solid, liquid, gas;

2) metals, non-metals, metalloids;

3) naturally occurring and man made.

1A	2A		3B-8B										1B	2B	3A	4A	5A	6A	7A	8A
1 H <sub>2</sub> GAS															5 B RHOM	6 C HEX	7 N GAS	8 O GAS	9 F GAS	10 Ne GAS
3 Li BCC	4 Be HEX													13 Al FCC	14 Si FCC	15 P CUBIC	16 S ORTHO	17 Cl GAS	18 Ar GAS	
11 Na BCC	12 Mg HEX	3B	4B	5B	6B	7B	8B			1B	2B	31 Ga ORTHO	32 Ge FCC	33 As RHOM	34 Se HEX	35 Br LIQUID	36 Kr GAS			
19 K BCC	20 Ca FCC	21 Sc HEX	22 Ti HEX	23 V BCC	24 Cr BCC	25 Mn BCC	26 Fe BCC	27 Co HEX	28 Ni FCC	29 Cu FCC	30 Zn HEX	49 In TETRA	50 Sn TETRA	51 Sb RHOM	52 Te HEX	53 I ORTHO	54 Xe GAS			
37 Rb BCC	38 Sr FCC	39 Y HEX	40 Zr HEX	41 Nb BCC	42 Mo BCC	43 Tc HEX	44 Ru HEX	45 Rh FCC	46 Pd FCC	47 Ag FCC	48 Cd HEX	81 Tl HEX	82 Pb FCC	83 Bi RHOM	84 Po CUBIC	85 At UNK	86 Rn GAS			
55 Cs BCC	56 Ba BCC	57-71 Lanthanides	72 Hf HEX	73 Ta BCC	74 W BCC	75 Re HEX	76 Os HEX	77 Ir FCC	78 Pt FCC	79 Au FCC	80 Hg LIQUID									
87 Fr UNK	88 Ra BCC	89-103 Actinides	*** Elements > 104 exist only for very short half-lives and the data is unknown.***																	

Lanthanides	57 La HEX	58 Ce FCC	59 Pr HEX	60 Nd HEX	61 Pm HEX	62 Sm RHOM	63 Eu BCC	64 Gd HEX	65 Tb HEX	66 Dy HEX	67 Ho HEX	68 Er HEX	69 Tm HEX	70 Yb FCC	71 Lu HEX
Actinides	89 Ac FCC	90 Th FCC	91 Pa TETRA	92 U ORTHO	93 Np ORTHO	94 Pu MONO	95 Am HEX	96 Cm HEX	97 Bk HEX	98 Cf HEX	99 Es HEX	100 Fm UNK	101 Md UNK	102 No UNK	103 Lr UNK



# Metals, Nonmetals, and Metalloids

## Metals

As one goes across a period, the properties of elements become less metallic and more nonmetallic. About 80% of the elements are metals.

The periodic table is color-coded to show the classification of elements:

- Metals:** Yellow background (left side, including the transition metals).
- Metalloids:** Green background (diagonal line from Boron to Astatine).
- Nonmetals:** Teal background (right side, including noble gases).

A red circle highlights the Metals region, and a yellow arrow points from the right towards the left across the top of the table, indicating the trend of decreasing metallic character across a period.

1 IA 1A	2 IIA 2A											13 IIIB 3A	14 IVB 4A	15 VB 5A	16 VIB 6A	17 VIIB 7A	18 VIIIB 8A
1 H	2 He											5 B	6 C	7 N	8 O	9 F	10 Ne
2 3 Li	4 Be	3 III A 3B	4 IV A 4B	5 V A 5B	6 VI A 6B	7 VII A 7B	8 VIII A 8B	9	10	11 IB 1B	12 IIB 2B	13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
3 11 Na	12 Mg	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
4 19 K	20 Ca	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
5 37 Rb	38 Sr	71 Lu	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
6 55 Cs	56 Ba	103 Lr	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Uut	114 Uuq	115 Uup	116 Uuh	117 Uus	118 Uuo
7 87 Fr	88 Ra	103 Lr	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Uut	114 Uuq	115 Uup	116 Uuh	117 Uus	118 Uuo
		57 La	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		
		89 Ac	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		

# Metals

- Good conductors of heat and electric current.
- High **luster**, or sheen ... ability to reflect light.
- Solids at room temperature, except for mercury (Hg).
- **Ductile**, can be drawn into wires.
- **Malleable**, can be hammered into thin sheets without breaking.
- **Hard & Strong**

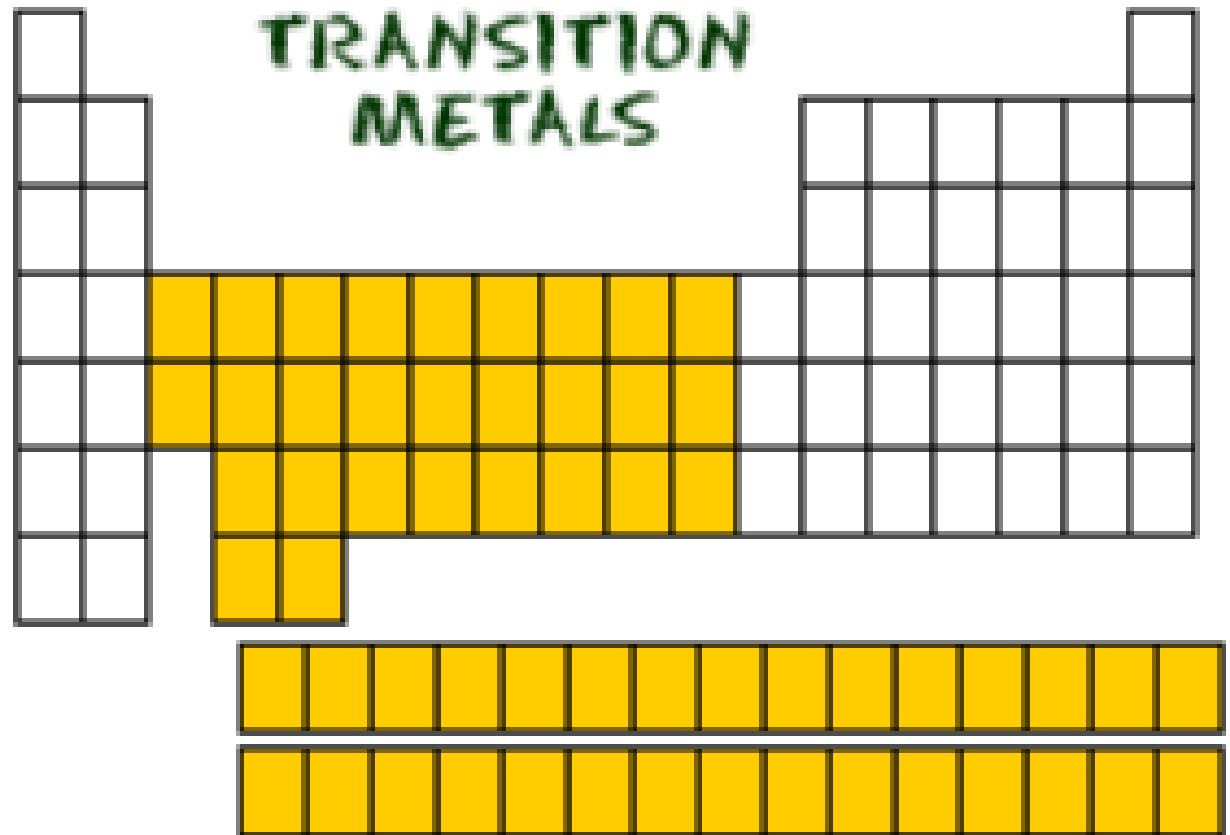


## Transition Metals

**Transition metals** are elements that form a bridge between the elements on the left and right sides of the table. Known as **“B” groups**.

- Transition elements, such as copper and silver, were among the first elements discovered.

One property of many transition metals is their ability to form compounds with **distinctive colors**.



# Metals, Semimetals, and Nonmetals

## Nonmetals

- Brittle, poor conductors, can be solid, liquid, or gas.

				<b>2</b> <b>He</b> Helium 4.00
<b>6</b> <b>C</b> Carbon 12.01	<b>7</b> <b>N</b> Nitrogen 14.01	<b>8</b> <b>O</b> Oxygen 16.00	<b>9</b> <b>F</b> Fluorine 19.00	<b>10</b> <b>Ne</b> Neon 20.18
	<b>15</b> <b>P</b> Phosphorus 30.97	<b>16</b> <b>S</b> Sulfur 32.07	<b>17</b> <b>Cl</b> Chlorine 35.45	<b>18</b> <b>Ar</b> Argon 39.95
		<b>34</b> <b>Se</b> Selenium 78.96	<b>35</b> <b>Br</b> Bromine 79.90	<b>36</b> <b>Kr</b> Krypton 83.80
			<b>53</b> <b>I</b> Iodine 126.90	<b>54</b> <b>Xe</b> Xenon 131.29
			<b>85</b> <b>At</b> Astatine 209.99	<b>86</b> <b>Rn</b> Radon 222.02
			<b>117</b> <b>Uus</b> Ununseptium Unknown	<b>118</b> <b>Uuo</b> Ununoctium 294.00

# Metals, Nonmetals, and Metalloids

## Nonmetals

- Tend to have properties opposite of metals.
- Usually **poor conductors & brittle**.

The periodic table is color-coded to show the distribution of Metals, Metalloids, and Nonmetals. Metals are shown in yellow, Metalloids in green, and Nonmetals in blue. A red circle highlights the Nonmetals region, and a blue arrow points from the Metalloids region towards the Nonmetals region.

1 IA 1A	2 IIA 2A											13 IIIB 3A	14 IVB 4A	15 VB 5A	16 VIB 6A	17 VIIB 7A	18 VIIIB 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	3 IIIA 3B	4 IVA 4B	5 VA 5B	6 VIA 6B	7 VIIA 7B	8 VIII 8B	9 VIII 8B	10 VIII 8B	11 IB 1B	12 IIB 2B	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	71 Lu	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	103 Lr	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Uut	114 Uuq	115 Uup	116 Uuh	117 Uus	118 Uuo
		57 La	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		
		89 Ac	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		

# Metals, Semimetals, and Nonmetals

## Semimetals (metalloids)

- Properties of both metals and nonmetals.

5 <b>B</b> Boron 10.81				
	14 <b>Si</b> Silicon 28.09			
	32 <b>Ge</b> Germanium 72.61	33 <b>As</b> Arsenic 74.92		
		51 <b>Sb</b> Antimony 121.76	52 <b>Te</b> Tellurium 127.60	
			84 <b>Po</b> Polonium 209	



# Metals, Nonmetals, and Metalloids

## Metalloids

- “Staircase Elements” that sometimes behave like metals.
- Under other conditions, they may behave like nonmetals.
- Silicon is also present as the compound silicon dioxide in glass items and the earth’s crust (*silica*).

1 IA 1A	2 IIA 2A											13 IIIB 3A	14 IVB 4A	15 VB 5A	16 VIB 6A	17 VIIB 7A	18 VIIIB 8A		
1 H																	2 He		
2 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne		
3 Na	12 Mg	3 IIIA 3B	4 IVA 4B	5 VA 5B	6 VIA 6B	7 VIIA 7B	8 VIII 8B			9	10	11 IB 1B	12 IIB 2B	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	71 Lu	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	103 Lr	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Uut	114 Uuq	115 Uup	116 Uuh	117 Uus	118 Uuo		
		57 La	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				
		89 Ac	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				



# Information for Each Element

Atomic Number

11

**Na**

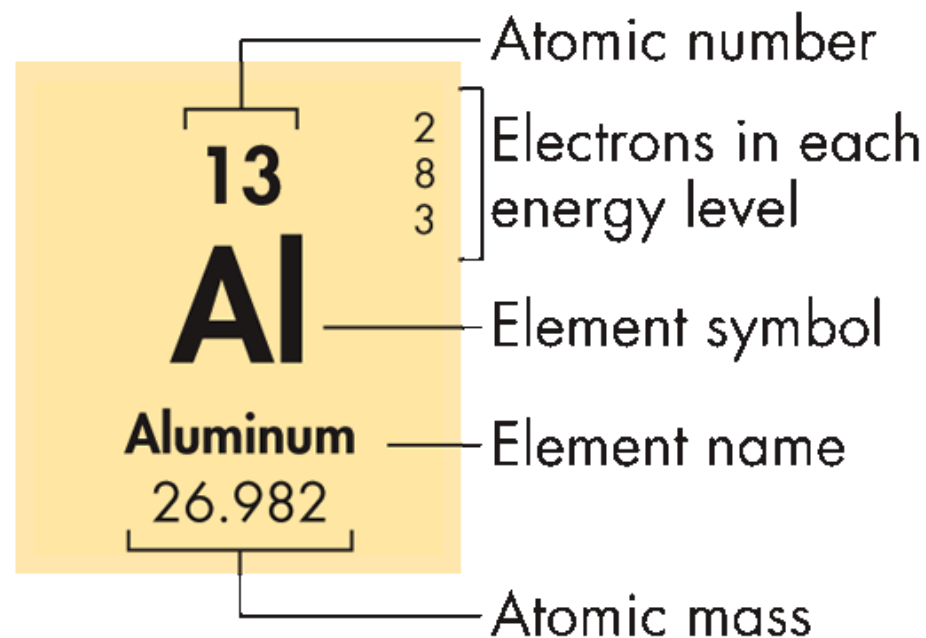
Sodium

Average Atomic Mass

22.99

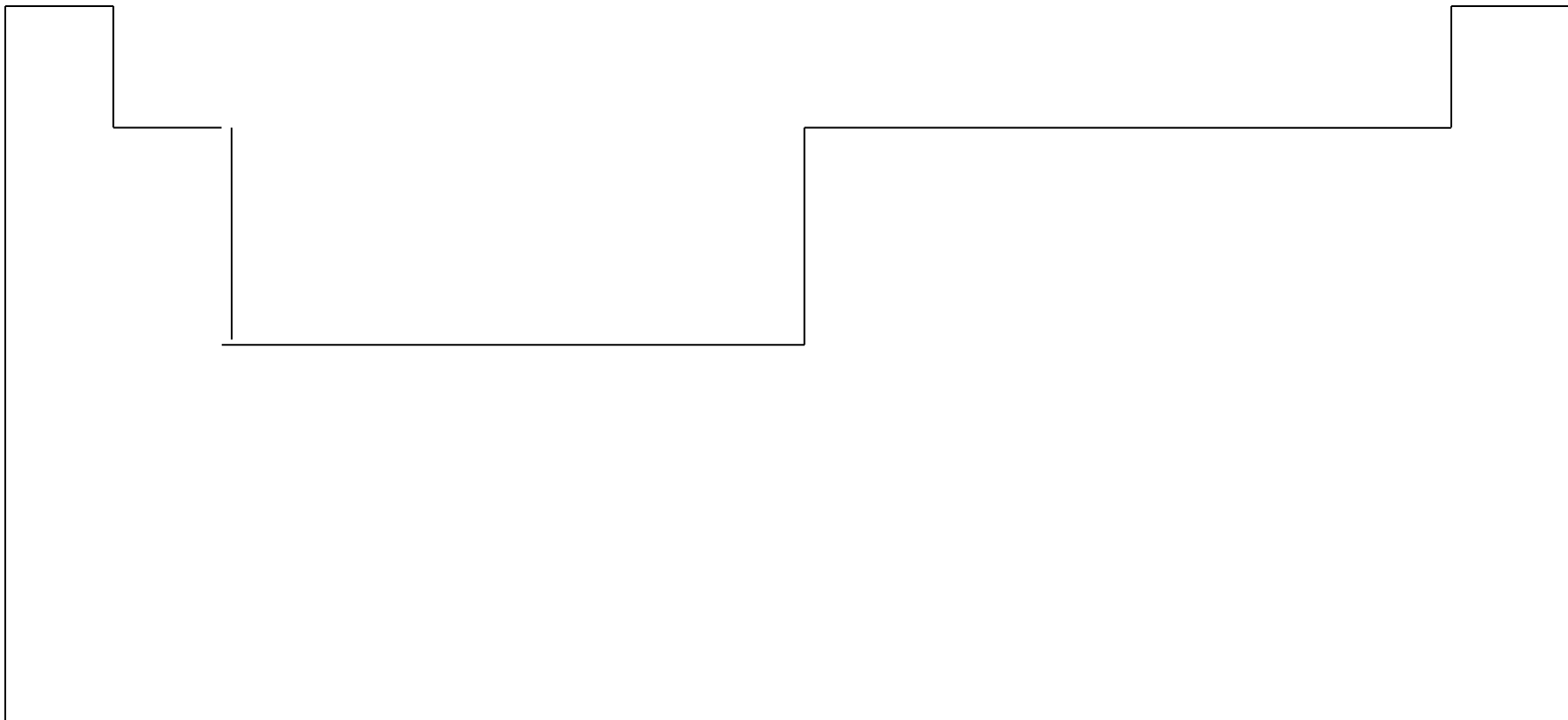
Each element's entry on the periodic table shows:

- Chemical symbol
- Element name
- Atomic number
- Average atomic mass
- Electron configuration



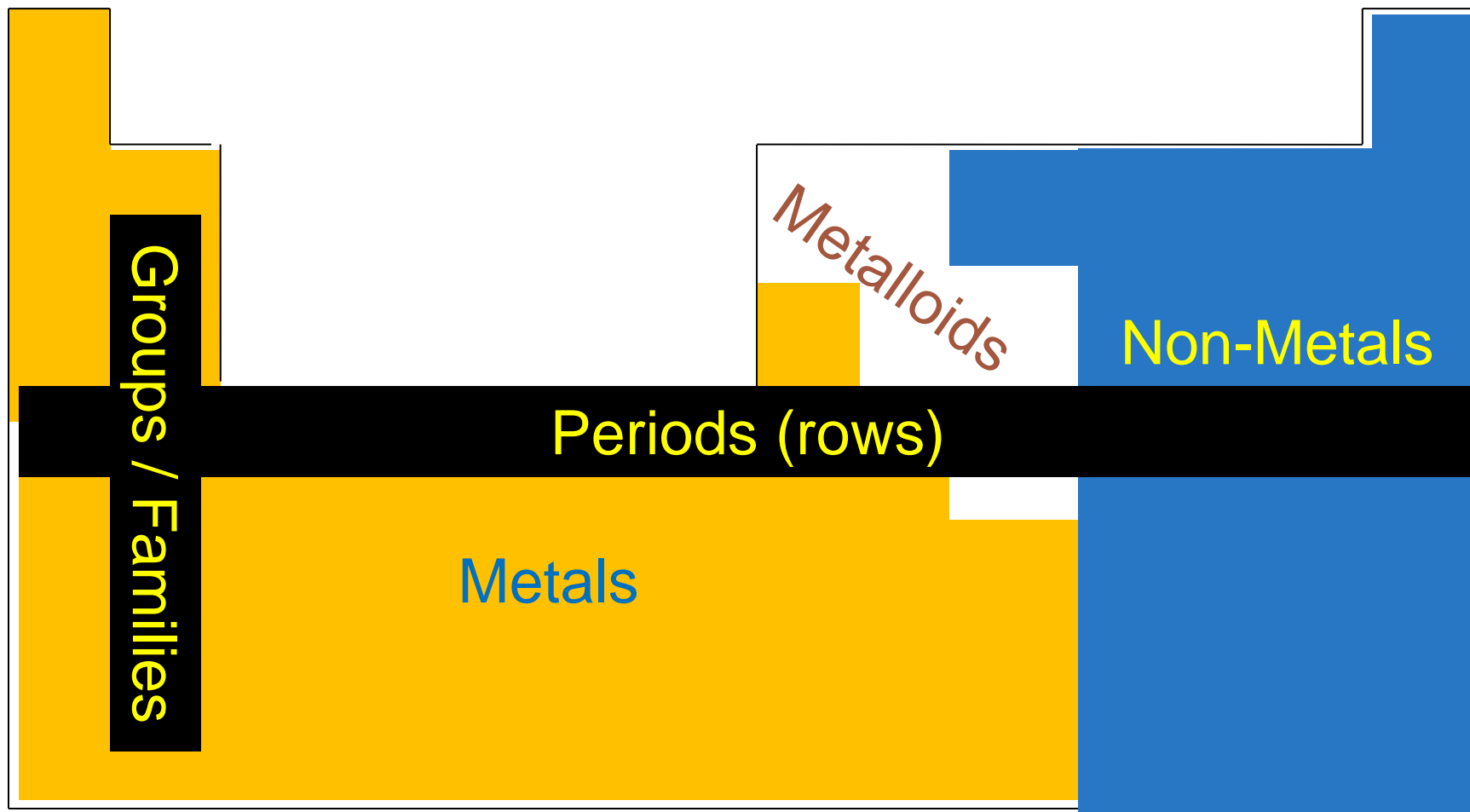
# Review of the Periodic Table

**Copy the Blank table and LABEL**



- Label metals, metalloids, and non-metals.
- Label periods and groups.

# Review of the Periodic Table



1. What determines the atomic mass of an element?

- a. the natural distribution of isotopes and the atomic numbers of those isotopes
- b. the natural distribution of isotopes and the masses of those isotopes
- c. the mass of the isotope of the element that has the most neutrons
- d. the average number of protons in the element's nucleus



2. Which of the following is not characteristic of metals?

- a. Ductile
- b. typically solid at room temperature
- c. good electrical conductor
- d. brittle

3. Within a period of the periodic table, how do the properties of the elements vary?

- a. Metallic characteristics increase from left to right.
- b. Metallic characteristics decrease from left to right.
- c. Reactivity increases from left to right.
- d. Reactivity decreases from left to right.

1. What determines the atomic mass of an element?
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  - a. Metallic characteristics increase from left to right.
  - b. Metallic characteristics decrease from left to right.**
  - c. Reactivity increases from left to right.
  - d. Reactivity decreases from left to right.

# Periodic Law

Periodic Table of the Elements

1A	1	2																	0					
	1																		2					
	H																		He					
	3	4																	5	6	7	8	9	10
	Li	Be																	B	C	N	O	F	Ne
	11	12	III B	IV B	V B	VIB	VII B	— VII —			IB	IIB	13	14	15	16	17	18						
	Na	Mg										Al	Si	P	S	Cl	Ar							
	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	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86						
	Cs	Ba	*La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn						

*When elements are arranged in order of increasing **atomic number**, there is a periodic pattern in their **physical** and **chemical properties**.*

# Valence

Families or Groups

	1A	2A	Transition Metal Family										3A	4A	5A	6A	7A	8A
1																		
2	Alkali Metal Family	Alkali EARTH Metal Family											Boron Family	Carbon Family	Nitrogen Family	Oxygen Family	Halogen Family	Noble Gas Family
3	Alkali Metal Family	Alkali EARTH Metal Family											Boron Family	Carbon Family	Nitrogen Family	Oxygen Family	Halogen Family	Noble Gas Family
4	Alkali Metal Family	Alkali EARTH Metal Family											Boron Family	Carbon Family	Nitrogen Family	Oxygen Family	Halogen Family	Noble Gas Family
5	Alkali Metal Family	Alkali EARTH Metal Family	Transition Metal Family										Boron Family	Carbon Family	Nitrogen Family	Oxygen Family	Halogen Family	Noble Gas Family
6	Alkali Metal Family	Alkali EARTH Metal Family											Boron Family	Carbon Family	Nitrogen Family	Oxygen Family	Halogen Family	Noble Gas Family
7	Alkali Metal Family	Alkali EARTH Metal Family											Boron Family	Carbon Family	Nitrogen Family	Oxygen Family	Halogen Family	Noble Gas Family

Lanthanide Series

Actinide Series

**Elements in a group have similar properties because they have the same number of valence electrons.**

A **valence electron** is an electron that is in the highest occupied energy level of an atom.



# Valence / "A" Groups

"A" groups on the periodic table are numbered from 1 through 8. The group number matches the number of **valence electrons** in the electron configuration of an element in that group.

Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
	1A	2A	3B	4B	5B	6B	7B	8B	8B	10B	11B	12B	3A	4A	5A	6A	7A	8A	
1	H Hydrogen 1.0078																	He Helium 4.0026	
2	Li Lithium 6.938	Be Beryllium 9.0122											B Boron 10.806	C Carbon 12.009	N Nitrogen 14.006	O Oxygen 15.999	F Fluorine 18.998	Ne Neon 20.180	
3	Na Sodium 22.990	Mg Magnesium 24.305											Al Aluminum 26.982	Si Silicon 28.084	P Phosphorus 30.974	S Sulfur 32.059	Cl Chlorine 35.446	Ar Argon 39.948	
4	K Potassium 39.098	Ca Calcium 40.078	Sc Scandium 44.956	Ti Titanium 47.867	V Vanadium 50.942	Cr Chromium 51.996	Mn Manganese 54.938	Fe Iron 55.845	Co Cobalt 58.933	Ni Nickel 58.693	Cu Copper 63.546	Zn Zinc 65.38	Ga Gallium 69.723	Ge Germanium 72.63	As Arsenic 74.922	Se Selenium 78.96	Br Bromine 79.904	Kr Krypton 83.798	
5	Rb Rubidium 85.448	Sr Strontium 87.62	Y Yttrium 88.906	Zr Zirconium 91.224	Nb Niobium 92.906	Mo Molybdenum 95.96	Tc Technetium 98.9062	Ru Ruthenium 101.07	Rh Rhodium 102.91	Pd Palladium 106.42	Ag Silver 107.87	Cd Cadmium 112.41	In Indium 114.82	Sn Tin 118.71	Sb Antimony 121.76	Te Tellurium 127.60	I Iodine 126.90	Xe Xenon 131.29	
6	Cs Cesium 132.91	Ba Barium 137.33		Hf Hafnium 178.49	Ta Tantalum 180.95	W Tungsten 183.84	Re Rhenium 186.21	Os Osmium 190.23	Ir Iridium 192.22	Pt Platinum 195.08	Au Gold 196.97	Hg Mercury 200.59	Tl Thallium 204.38	Pb Lead 207.2	Bi Bismuth 208.98	Po Polonium (209)	At Astatine (210)	Rn Radon (222)	
7	Fr Francium (223)	Ra Radium (226)		Rf Rutherfordium (261)	Db Dubnium (262)	Sg Seaborgium (266)	Bh Bohrium (264)	Hs Hassium (269)	Mt Meitnerium (268)	Ds Darmstadtium (268)	Rg Roentgenium (268)	Cn Copernicium (268)	Uut Ununtrium (268)	Fl Flerovium (268)	Uup Ununpentium (268)	Lv Livermorium (268)	Uus Ununseptium (268)	Uuo Ununoctium (268)	
			Lanthanides																
			La Lanthanum 138.91	Ce Cerium 140.12	Pr Praseodymium 140.91	Nd Neodymium 144.24	Pm Promethium (145)	Sm Samarium 150.36	Eu Europium 151.96	Gd Gadolinium 157.25	Tb Terbium 158.93	Dy Dysprosium 162.50	Ho Holmium 164.93	Er Erbium 167.26	Tm Thulium 168.93	Yb Ytterbium 173.04	Lu Lutetium 174.97		
			Actinides																
			Ac Actinium (227)	Th Thorium 232.04	Pa Protactinium 231.04	U Uranium 238.03	Np Neptunium (237)	Pu Plutonium (244)	Am Americium (243)	Cm Curium (247)	Bk Berkelium (247)	Cf Californium (251)	Es Einsteinium (252)	Fm Fermium (257)	Md Mendelevium (258)	No Nobelium (259)	Lr Lawrencium (262)		

## Group 1A

3  
**Li**

Lithium

11

**Na**

Sodium

19

**K**

Potassium

37

**Rb**

Rubidium

55

**Cs**

Cesium

87

**Fr**

Francium

Periodic Table  
of the Elements

																								0 2 He	
IIA 4 Be											IIIA 5 B	IVA 6 C	VA 7 N	VIA 8 O	VIIA 9 F										
12 Mg																									
III B	IV B	V B	VIB	VIB	VIB	VII																			
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									
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									
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									
88 Ra	89 +Ac	104 Rf	105 Ha	106 Sg	107 Ns	108 Hs	109 Mt	110 110	111 111	112 112	113 113														

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

*1*  
*valence*  
*electron*

*Alkali Metals*

# Alkali Metals (Group IA)

- Group 1 or IA
- Easily lose an electron *in order to gain ideal electron configuration.*
- Typical properties:
  - Silver in color
  - Soft (can be cut with a knife)
  - Highly reactive with oxygen and water
  - Able to oxidize in air



**Group 2A**

4 <b>Be</b> Beryllium																	2 <b>He</b>
12 <b>Mg</b> Magnesium																	10 <b>Ne</b>
20 <b>Ca</b> Calcium																	18 <b>Ar</b>
38 <b>Sr</b> Strontium																	36 <b>Kr</b>
56 <b>Ba</b> Barium																	54 <b>Xe</b>
88 <b>Ra</b> Radium																	86 <b>Rn</b>

1 <b>H</b>																	2
3 <b>Li</b>																	10
11 <b>Na</b>																	18
19 <b>K</b>																	36
37 <b>Rb</b>																	54
55 <b>Cs</b>																	86
87 <b>Fr</b>																	118

23 <b>V</b>	24 <b>Cr</b>	25 <b>Mn</b>	26 <b>Fe</b>	27 <b>Co</b>	28 <b>Ni</b>	29 <b>Cu</b>	30 <b>Zn</b>	31 <b>Ga</b>	32 <b>Ge</b>	33 <b>As</b>	34 <b>Se</b>	35 <b>Br</b>	36 <b>Kr</b>
41 <b>Nb</b>	42 <b>Mo</b>	43 <b>Tc</b>	44 <b>Ru</b>	45 <b>Rh</b>	46 <b>Pd</b>	47 <b>Ag</b>	48 <b>Cd</b>	49 <b>In</b>	50 <b>Sn</b>	51 <b>Sb</b>	52 <b>Te</b>	53 <b>I</b>	54 <b>Xe</b>
73 <b>Ta</b>	74 <b>W</b>	75 <b>Re</b>	76 <b>Os</b>	77 <b>Ir</b>	78 <b>Pt</b>	79 <b>Au</b>	80 <b>Hg</b>	81 <b>Tl</b>	82 <b>Pb</b>	83 <b>Bi</b>	84 <b>Po</b>	85 <b>At</b>	86 <b>Rn</b>
105 <b>Ha</b>	106 <b>Sg</b>	107 <b>Ns</b>	108 <b>Hs</b>	109 <b>Mt</b>	110 <b>110</b>	111 <b>111</b>	112 <b>112</b>	113 <b>113</b>					

50 <b>Nd</b>	61 <b>Pm</b>	62 <b>Sm</b>	63 <b>Eu</b>	64 <b>Gd</b>	65 <b>Tb</b>	66 <b>Dy</b>	67 <b>Ho</b>	68 <b>Er</b>	69 <b>Tm</b>	70 <b>Yb</b>	71 <b>Lu</b>
92 <b>U</b>	93 <b>Np</b>	94 <b>Pu</b>	95 <b>Am</b>	96 <b>Cm</b>	97 <b>Bk</b>	98 <b>Cf</b>	99 <b>Es</b>	100 <b>Fm</b>	101 <b>Md</b>	102 <b>No</b>	103 <b>Lr</b>

\* Lanthanide Series  
+ Actinide Series

*2  
valence  
electrons*

# *Alkaline Earth Metals*

# Alkaline Earth Metals (**Group IIA**)

- Group 2 or IIA
- Lose two electrons *to gain ideal electron configuration.*
- Typical properties:
  - Silver in color
  - More brittle than alkali metals
  - Somewhat reactive
  - Low in density, with low melting and boiling points



	1A (1)																8A (18)	
1		2A (2)												3A (13)	4A (14)	5A (15)	6A (16)	7A (17)
2			TRANSITION ELEMENTS															
3			3B (3)	4B (4)	5B (5)	6B (6)	7B (7)	8B (8) (9) (10)			1B (11)	2B (12)						
4			21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn						
5			39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd						
6			57 La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg						
7			89 Ac	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110	111	112						

**B**  
Groups

INNER TRANSITION ELEMENTS

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

# Transition Metals

# Transition Metals (B Groups)

- Characterized by the presence of valence electrons in special orbitals.

e.g. **Copper**, **silver**, **gold**, **iron**

- Form colored compounds
- May have unusual properties:
  - Magnetism
  - High conductivity
- “Inner” transition metals are rare; often radioactive



# Periodic Table of the Elements

1 H																	2 He
3 Li	4 Be											5 B	6 C	7 N	<b>Group 7A</b> 9 F Fluorine	10 Ne	
11 Na	12 Mg	III B	IV B	V B	VIB	VII B	— VII —			IB	IIB	13 Al	14 Si	15 P	17 Cl Chlorine	18 Ar	
19 K	20 Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	31 Ga	32 Ge	33 As	35 Br Bromine	36 Kr	
37 Rb	38 Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	49 In	50 Sn	51 Sb	54 Xe		
55 Cs	56 Ba	*La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	81 Tl	82 Pb	83 Bi	86 Rn		
87 Fr	88 Ra	+Ac	Rf	Ha	Sg	Ns	Hs	Mt	110	111	112	113					

*7  
valence  
electrons*

\* Lanthanide Series  
+ Actinide Series

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
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# Halogens



# Halogens (Group VIIA)

- Group 17 or VIIA
- Easily gain an electron *to gain ideal electron configuration*
- Typical properties
  - Highly reactive with metals
  - Toxic to organisms
  - Most occur as diatomic molecules ( $F_2$ ,  $Cl_2$ ,  $Br_2$ ,  $I_2$ )
  - React with metals to form salts



**8**  
*valence electrons*  
**"FULL"**

# Periodic Table of the Elements

										IIIA	IVA	VA	VIA	VIIA									
										5 B	6 C	7 N	8 O	9 F									
										13 Al	14 Si	15 P	16 S	17 Cl									
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										
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										
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										
104 Rf	105 Ha	106 Sg	107 Ns	108 Hs	109 Mt	110 110	111 111	112 112	113 113														
* Lanthanide Series										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
+ Actinide Series										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

**Group 8A**

2 <b>He</b> Helium
10 <b>Ne</b> Neon
18 <b>Ar</b> Argon
36 <b>Kr</b> Krypton
54 <b>Xe</b> Xenon
86 <b>Rn</b> Radon

# Noble Gases

# Noble Gases (Group VIII A)

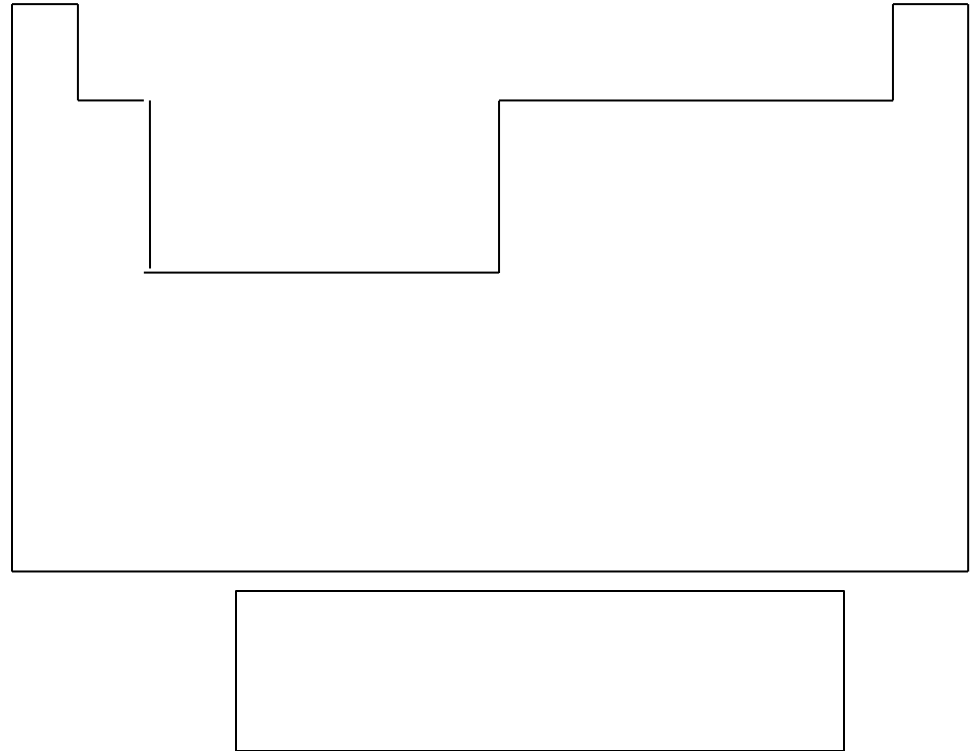
- Group 18 or VIII A
- **Inert gases** (nonreactive)  
*have ideal electron configuration*
- Typical properties
  - Odorless and tasteless
  - Nonreactive and nonflammable
  - Have extremely low boiling points (i.e. gases)
  - Produce characteristic colors when excited electrically



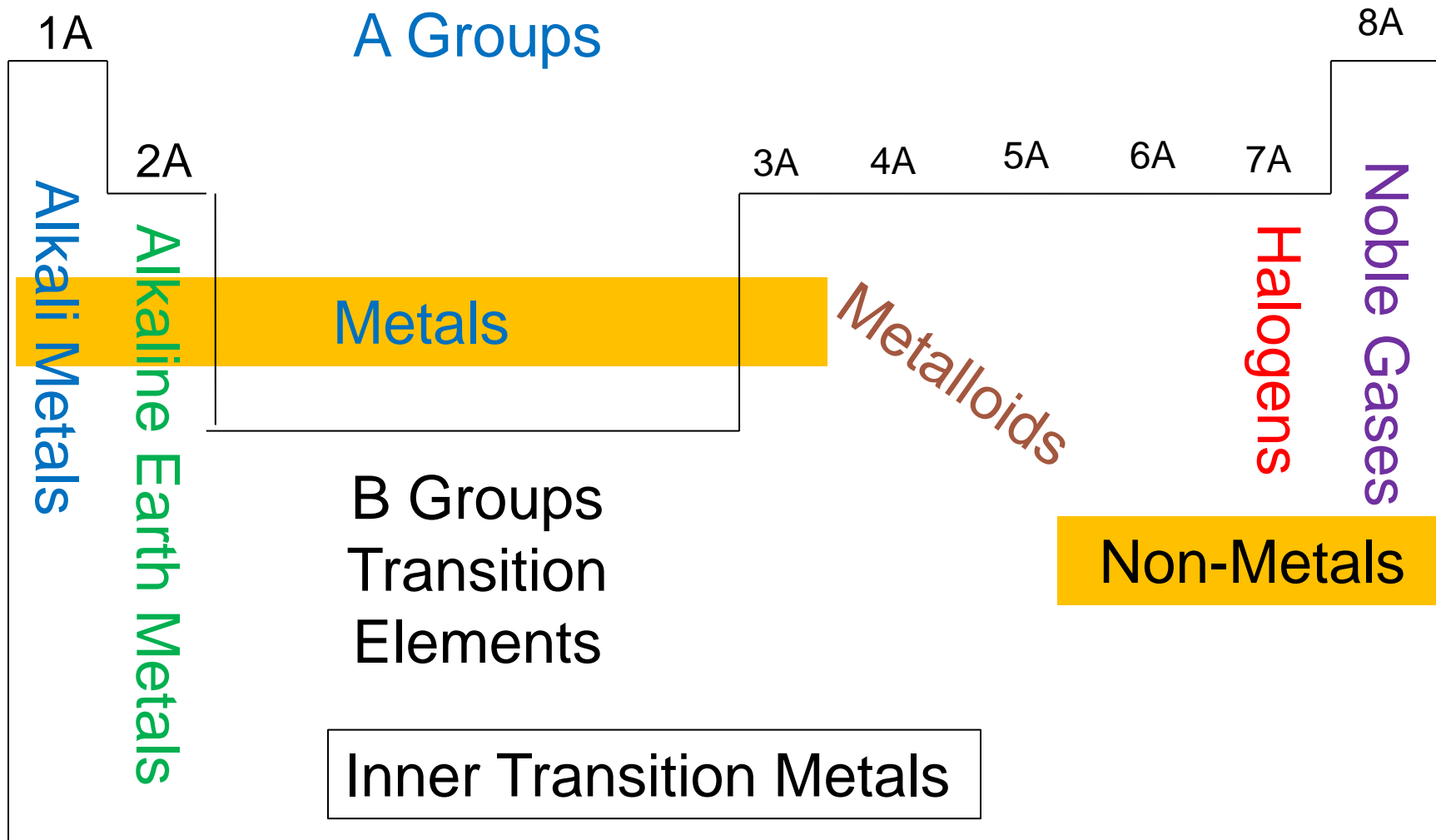
# Review of the Periodic Table



- **A** Groups with valence electron configuration
- **B** Groups (transition elements, inner transition)
- Metals, non-metals, metalloids
- Alkali & Alkaline Earth Metals, Halogens, Noble Gases
- How many valence electrons in the “A” groups?



# Review of the Periodic Table



1. Why do elements in a group have similar chemical properties?

- a. They have the same number of valence electrons.
- b. They have the same ratio of protons to neutrons.
- c. Their atomic masses are multiples of the least massive element of the group.
- d. They have the same number of total electrons.



2. In general, the metallic characteristics of A group elements within a period decreases from \_\_\_\_\_ to \_\_\_\_\_.

3. Which “A” group elements tend to lose electrons? Gain electrons? Why?

1. Why do elements in a group have similar chemical properties?

a. **They have the same number of valence electrons.**

b. They have the same ratio of protons to neutrons.

c. Their atomic masses are multiples of the least massive element of the group.

d. They have the same number of total electrons.

2. In general, the metallic characteristics of A group elements within a period decreases from **left to right**.

3. Which “A” group elements tend to lose electrons? Gain electrons? Why?

**Groups 1A – 3A lose electrons**

**Groups 5A – 7A gain electrons**

**Atoms gain or lose electrons to complete their valence (outer electron configuration).**



QUICK CHECK

# The Arrangement of the Periodic Table



The periodic table contains a great deal of information on the elements.

- *Periods* refer to horizontal rows of the periodic table.
- *Groups* or *families* refer to vertical columns of the periodic table.
- Cells of the periodic table contain information such as the atomic symbol, atomic number, atomic mass, name of the element, electron configuration, and possible oxidation numbers.
- Elements can be categorized broadly as metals, nonmetals, or semimetals (metalloids).



# Classifying the Elements



## Groups

- Alkali metals: most reactive metals, soft, oxidize quickly.
- Alkaline earth metals: not as reactive as alkali metals, brittle, shiny.
- Transition metals: form colored compounds, good conductors of electricity.
- Halogens: most reactive nonmetals.
- Noble gases: lowest chemical reactivity, used in lighting.
- Inner transition metals: radioactive, used in nuclear power plants.

# Songs

The Periodic Table Song (2:44)

<http://somup.com/cF6QFinnyQ>

Tom Lehrer (1970 ... 1:47)

[The Elements Song](#)

<http://somup.com/cFQ22hVSKJ>

The Periodic Table REVIEW Song (3:07)

<http://somup.com/cq6f2ge7g4>



masses are  
2.00000

s-block  
18  
0

ation States

4.00260	0
<b>He</b>	
2	
1s <sup>2</sup>	

p-block  
**GROUP**

			13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 0	
			10.81 <b>B</b> 5 1s <sup>2</sup> 2s <sup>2</sup> 2p <sup>1</sup>	12.0111 <b>C</b> 6 1s <sup>2</sup> 2s <sup>2</sup> 2p <sup>2</sup>	14.0067 <b>N</b> 7 1s <sup>2</sup> 2s <sup>2</sup> 2p <sup>3</sup>	15.9994 <b>O</b> 8 1s <sup>2</sup> 2s <sup>2</sup> 2p <sup>4</sup>	18.998403 <b>F</b> 9 1s <sup>2</sup> 2s <sup>2</sup> 2p <sup>5</sup>	20.179 <b>Ne</b> 10 1s <sup>2</sup> 2s <sup>2</sup> 2p <sup>6</sup>	
			26.98154 <b>Al</b> 13 [Ne]3s <sup>2</sup> 3p <sup>1</sup>	28.0855 <b>Si</b> 14 [Ne]3s <sup>2</sup> 3p <sup>2</sup>	30.97376 <b>P</b> 15 [Ne]3s <sup>2</sup> 3p <sup>3</sup>	32.06 <b>S</b> 16 [Ne]3s <sup>2</sup> 3p <sup>4</sup>	35.453 <b>Cl</b> 17 [Ne]3s <sup>2</sup> 3p <sup>5</sup>	39.948 <b>Ar</b> 18 [Ne]3s <sup>2</sup> 3p <sup>6</sup>	
10	11 IB	12 IIB	69.72 <b>Ga</b> 31 [Ar]3d <sup>10</sup> 4s <sup>2</sup> 4p <sup>1</sup>	72.59 <b>Ge</b> 32 [Ar]3d <sup>10</sup> 4s <sup>2</sup> 4p <sup>2</sup>	74.9216 <b>As</b> 33 [Ar]3d <sup>10</sup> 4s <sup>2</sup> 4p <sup>3</sup>	78.96 <b>Se</b> 34 [Ar]3d <sup>10</sup> 4s <sup>2</sup> 4p <sup>4</sup>	79.904 <b>Br</b> 35 [Ar]3d <sup>10</sup> 4s <sup>2</sup> 4p <sup>5</sup>	83.80 <b>Kr</b> 36 [Ar]3d <sup>10</sup> 4s <sup>2</sup> 4p <sup>6</sup>	
58.69 <b>Ni</b> 28 [Ar]3d <sup>8</sup> 4s <sup>2</sup>	63.546 <b>Cu</b> 29 [Ar]3d <sup>10</sup> 4s <sup>1</sup>	65.39 <b>Zn</b> 30 [Ar]3d <sup>10</sup> 4s <sup>2</sup>	106.42 <b>Pd</b> 46 [Kr]4d <sup>10</sup> 5s <sup>0</sup>	114.82 <b>In</b> 49 [Kr]4d <sup>10</sup> 5s <sup>2</sup> 5p <sup>1</sup>	118.71 <b>Sn</b> 50 [Kr]4d <sup>10</sup> 5s <sup>2</sup> 5p <sup>2</sup>	121.75 <b>Sb</b> 51 [Kr]4d <sup>10</sup> 5s <sup>2</sup> 5p <sup>3</sup>	127.60 <b>Te</b> 52 [Kr]4d <sup>10</sup> 5s <sup>2</sup> 5p <sup>4</sup>	126.905 <b>I</b> 53 [Kr]4d <sup>10</sup> 5s <sup>2</sup> 5p <sup>5</sup>	131.29 <b>Xe</b> 54 [Kr]4d <sup>10</sup> 5s <sup>2</sup> 5p <sup>6</sup>
195.08 <b>Pt</b> 78 [Xe]4f <sup>14</sup> 5d <sup>9</sup> 6s <sup>1</sup>	196.967 <b>Au</b> 79 [Xe]4f <sup>14</sup> 5d <sup>10</sup> 6s <sup>1</sup>	200.59 <b>Hg</b> 80 [Xe]4f <sup>14</sup> 5d <sup>10</sup> 6s <sup>2</sup>	204.383 <b>Tl</b> 81 [Xe]4f <sup>14</sup> 5d <sup>10</sup> 6s <sup>2</sup> 6p <sup>1</sup>	207.2 <b>Pb</b> 82 [Xe]4f <sup>14</sup> 5d <sup>10</sup> 6s <sup>2</sup> 6p <sup>2</sup>	208.980 <b>Bi</b> 83 [Xe]4f <sup>14</sup> 5d <sup>10</sup> 6s <sup>2</sup> 6p <sup>3</sup>	(209) <b>Po</b> 84 [Xe]4f <sup>14</sup> 5d <sup>10</sup> 6s <sup>2</sup> 6p <sup>4</sup>	(210) <b>At</b> 85 [Xe]4f <sup>14</sup> 5d <sup>10</sup> 6s <sup>2</sup> 6p <sup>5</sup>	(222) <b>Rn</b> 86 [Xe]4f <sup>14</sup> 5d <sup>10</sup> 6s <sup>2</sup> 6p <sup>6</sup>	