

Unit 4 The Periodic Table  
**Periodic Table History**


### Periodic Table History

**1817 – Döbereiner**

Grouped elements in **TRIADS**

Three elements with similar properties

Alkali formers	Salt formers
Li 7	Cl 35.5
Na 23	Br 80
K 39	I 127



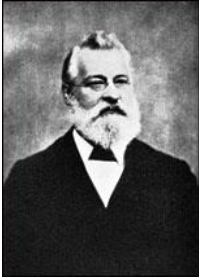
### Periodic Table History

**1865 – Newlands**

**Law of Octaves**

Similar properties every EIGHT elements

H	Li	Ca	B	C	N	O
F	Na	Mg	Al	Si	P	S
Cl	K	Ca	Cr	Ti	Mn	Fe
Co, Ni	Cu	Zn	Y	In	As	Se
Br	Rb	Sr	Ca, La	Zr	Er, Mo	Rh, Ru
Pd	Ag	Cd	U	Sr	Sn	Te
I	Ct	Ba, V	Ta	W	Nb	Au
Pl, Ir	Tl	Pb	Th	Hg	Bi	Cs

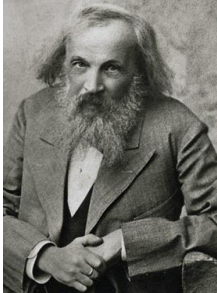


### Periodic Table History

**1870 – Mendeleev**

8 Column table based on **ATOMIC MASS**

Elements with similar properties were in the same column



### Mendeleev Table

	Gruppe I. RO	Gruppe II. RO	Gruppe III. RO <sup>2</sup>	Gruppe IV. RH <sup>4</sup> RO <sup>2</sup>	Gruppe V. RH <sup>3</sup> RO <sup>3</sup>	Gruppe VI. RH <sup>2</sup> RO <sup>3</sup>	Gruppe VII. RH RO <sup>2</sup>	Gruppe VIII. — RO <sup>3</sup>
1	H = 1							
2	Li = 7	Be = 9.4	B = 11	C = 12	N = 14	O = 16	F = 19	
3	N = 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 = 60, Cu = 63.
5	(Cu = 63)	Zn = 65	— = 68	— = 72	As = 75	Se = 78	Br = 80	
6	Rb = 85	Sr = 87	?Y = 88	Zr = 90	Nb = 94	Mo = 96	— = 100	Ru = 104, Rh = 104, Pd = 106, Ag = 104.
7	(Ag = 104)	Cd = 112	In = 113	Sn = 118	Sb = 122	Te = 125	J = 127	
8	Cs = 133	Ba = 137	?Di = 138	?Ce = 140				
9	—	—	?Er = 178	?La = 180	Ta = 182	W = 184		
10	—	—	—	—	—	—		Os = 195, Ir = 197, Pt = 195, Au = 199.
11	(Au = 199)	Hg = 200	Tl = 204	Pb = 207	Bi = 208			
12	—	—	—	Th = 231	—	U = 240		


<https://www.youtube.com/watch?v=kuQ0Um4Wcz0>

### Periodic Table History

**1913 – Moseley**

Arranged elements based on **ATOMIC NUMBER**

**PERIODIC LAW:**  
 The properties of the elements recur periodically as their atomic numbers increase

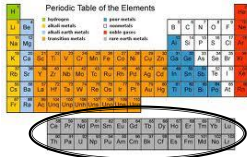


Henry Gwyn Jeffreys Moseley

# Periodic Table History

1944 – Seaborg

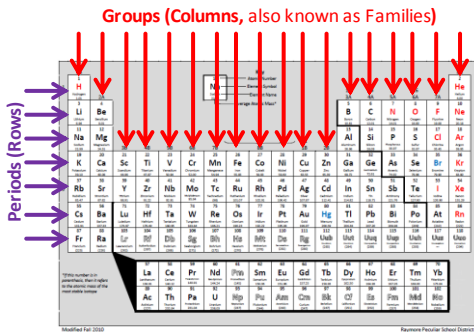
Last rearrangement of the periodic table – created the actinide series (**f-block**)



Unit 4 The Periodic Table

# Modern Periodic Table

# Groups vs. Periods



# Group Names

Group **A** Main Group Elements (*s-block and p-block*)

Group **B** Transition Elements.

**1A** Alkali Metals (H, Li, Na, K, Rb, Cs, Fr)

**2A** Alkaline Earth Metals (Be, Mg, Ca, Sr, Ba, Ra)

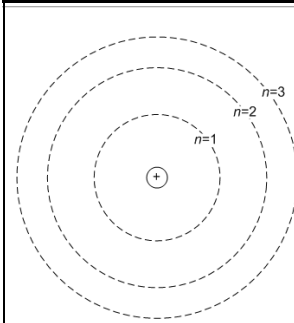
**3 – 12** Group B **\*\*Transition Metals\*\***

**7A** Halogens (F, Cl, Br, I, At)

**8A** Noble Gases (He, Ne, Ar, Kr, Xe, Rn)

1 1A H Hydrogen 1.01	2 2A He Helium 4.00	13 3A B Boron 10.81	14 4A C Carbon 12.01	15 5A N Nitrogen 14.01	16 6A O Oxygen 16.00	17 7A F Fluorine 18.99	18 8A Ne Neon 20.18																								
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 18.99	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 47.88	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 72.64	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 98.91	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 126.91	54 Xe Xenon 131.29														
55 Cs Cesium 132.91	56 Ba Barium 137.33	57 La Lanthanum 138.91	58 Ce Cerium 140.12	59 Pr Praseodymium 140.91	60 Nd Neodymium 144.24	61 Pm Promethium 144.91	62 Sm Samarium 150.36	63 Eu Europium 151.96	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 173.05	71 Lu Lutetium 174.97	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 Ac Actinium 227	90 Th Thorium 232.04	91 Pa Protactinium 231.04	92 U Uranium 238.03	93 Np Neptunium 237.05	94 Pu Plutonium 244.06	95 Am Americium 243.06	96 Cm Curium 247.07	97 Bk Berkelium 247.07	98 Cf Californium 251.08	99 Es Einsteinium 252.08	100 Fm Fermium 257.10	101 Md Mendelevium 258.10	102 No Nobelium 259.10	103 Lr Lawrencium 260.11	104 Rf Rutherfordium 261.10	105 Db Dubnium 262.11	106 Sg Seaborgium 263.11	107 Bh Bohrium 264.11	108 Hs Hassium 265.11	109 Mt Meitnerium 266.11	110 Ds Darmstadtium 267.11	111 Rg Roentgenium 268.11	112 Cn Copernicium 269.11	113 Nh Nihonium 270.11	114 Fl Flerovium 271.11	115 Mc Moscovium 272.11	116 Lv Livermorium 273.11	117 Ts Tennessine 274.11	118 Og Oganesson 277.11

# Valence Electrons



**VALENCE ELECTRONS**

Electrons in the **OUTERMOST SHELL**

**Highest Energy Level**  
(n = 1, 2, 3...)

## Highest Energy Level

### Group 1 (1A): Alkali Metals

Lithium (3e-)	$1s^2 2s^1$
Sodium (11e-)	$1s^2 2s^2 2p^6 3s^1$
Potassium (19e-)	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$

### Group 2 (2A): Alkaline Earth Metals

Beryllium (4e-)	$1s^2 2s^2$
Magnesium (12e-)	$1s^2 2s^2 2p^6 3s^2$
Calcium (20e-)	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$

## Highest Energy Level

### Group 17 (7A): Halogens

Fluorine (9e-)	$1s^2 2s^2 2p^5$
Chlorine (17e-)	$1s^2 2s^2 2p^6 3s^2 3p^5$
Bromine (35e-)	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^5$

### Group 18 (8A): Noble Gases

Neon (10e-)	$1s^2 2s^2 2p^6$
Argon (18e-)	$1s^2 2s^2 3s^2 3p^6$
Krypton (36e-)	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6$

## Modern Periodic Table

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18		
1	1A												3A	4A	5A	6A	7A	8A		
2	1	2											3	4	5	6	7	8		
3	1	2	3B	4B	5B	6B	7B	8B					1B	2B	3	4	5	6	7	8
4	1	2													3	4	5	6	7	8
5	1	2													3	4	5	6	7	8
6	1	2													3	4	5	6	7	8
7	1	2													3	4	5	6	7	8

## Modern Periodic Table

### OCTET RULE

8 valence electrons make the atom **UNREACTIVE**.

**Unreactive = Very Stable**

Atoms react with other atoms to fill their octet.

- Gain electrons. } Ionic Bonding
- Lose electrons. } Ionic Bonding
- Share electrons. } Covalent Bonding

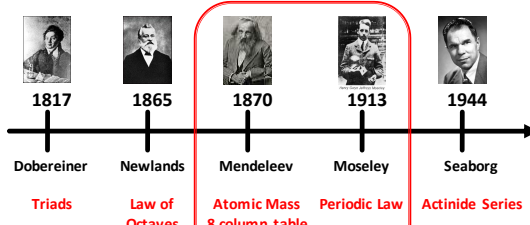
## Crash Course Chemistry

The Periodic Table

<https://www.youtube.com/watch?v=0RRVV4Diomg>



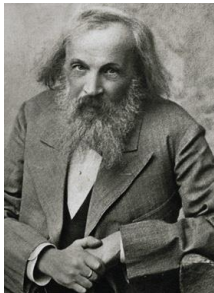
## Periodic Table Timeline



## Mendeleev Song

<http://www.youtube.com/watch?v=kuQOUm4Wcz0>

[http://www.youtube.com/watch?v=sm1uxjGm\\_N0](http://www.youtube.com/watch?v=sm1uxjGm_N0)



## Mendeleev Lab of 1869

1. Empty the contents of the envelope.
2. Separate out the **UNKNOWN** elements.
3. Organize the elements into an 8-column table.
4. Insert the **UNKNOWN** elements based on common characteristics.
5. Identify the **UNKNOWN** elements

## Mendeleev Lab of 1869

							He
Li	Be	B	C	N	O		Ne
Na		Al	Si	P		Cl	Ar
K	Ca	Ga		As	Se	Br	
	Sr	In	Sn		Te	I	Xe
Cs	Ba						

Unit 4 The Periodic Table

## Groups vs. Periods Metals vs. Nonmetals

## Metals and Nonmetals

## Metals and Nonmetals

METALS	NONMETALS
Typically Solids (Malleable and Ductile)	Gasses or BRITTLE solids
Shiny	Dull
Conductors (Heat and Electricity)	Insulators (Heat and Electricity)
<b>LOSE</b> valence electrons to fill octet	<b>GAIN</b> valence electrons to fill octet

## Metals and Nonmetals

**Metals**  
3 or fewer  
VALENCE electrons

**Nonmetals**  
5 or more  
VALENCE electrons

### Metalloids

Properties of both metals and nonmetals

Semiconductors  
(B, Si, Ge, As, Sb, Te, Po)

Unit 4 The Periodic Table

## Periodic Trends

## Periodic Trends

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9 9A Li Lithium 6.94	10 10A Be Beryllium 9.01	11 11A Na Sodium 22.99	12 12A Mg Magnesium 24.31	13 13A Al Aluminum 26.98	14 14A Si Silicon 28.09	15 15A P Phosphorus 30.97	16 16A S Sulfur 32.07	17 17A Cl Chlorine 35.45	18 18A Ar Argon 39.95								
19 19A K Potassium 39.10	20 20A Ca Calcium 40.08	21 1B Sc Scandium 44.96	22 2B Ti Titanium 47.88	23 3B V Vanadium 50.94	24 4B Cr Chromium 52.00	25 5B Mn Manganese 54.94	26 6B Fe Iron 55.85	27 7B Co Cobalt 58.93	28 8B Ni Nickel 58.69	29 9B Cu Copper 63.55	30 10B Zn Zinc 65.39	31 11B Ga Gallium 69.72	32 12B Ge Germanium 72.64	33 13B As Arsenic 74.92	34 14B Se Selenium 78.96	35 15B Br Bromine 79.90	36 16B Kr Krypton 83.80
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87 19A Fr Francium 223	88 20A Ra Radium 226	89 1B Ac Actinium 227	90 2B Th Thorium 232	91 3B Pa Protactinium 231	92 4B U Uranium 238	93 5B Np Neptunium 237	94 6B Pu Plutonium 244	95 7B Am Americium 243	96 8B Cm Curium 247	97 9B Bk Berkelium 247	98 10B Cf Californium 251	99 11B Es Einsteinium 252	100 12B Fm Fermium 257	101 13B Md Mendelevium 258	102 14B No Nobelium 259	103 15B Lr Lawrencium 260	104 16B Uuo Ununhexium 289

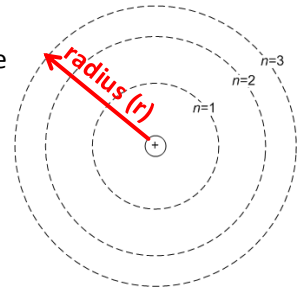
**PREDICTABLE**  
changes  
in a  
particular  
direction

(Focus on Main Group Elements)

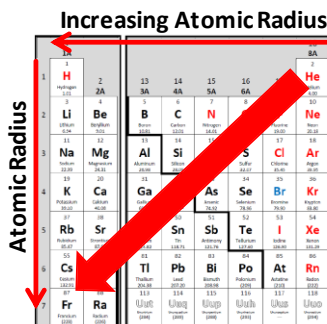
## Trend 1 Atomic Radius

The distance from the **nucleus** to the **valence shell**

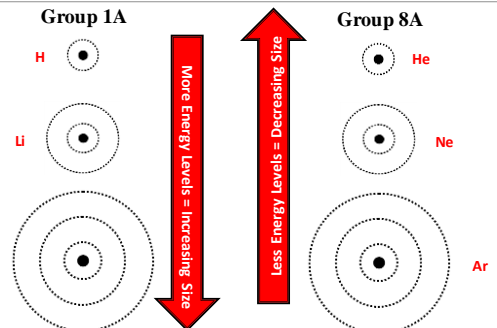
**\*SIMPLY PUT\***  
**Atom SIZE**



## Trend 1 Atomic Radius



## Trend 1 Atomic Radius



### Trend 1 Atomic Radius

More Protons = Stronger Pull = Smaller Atom

Carbon: 6 protons      Nitrogen: 7 protons      Oxygen: 8 protons

Period 2

Less Protons = Weaker Pull = Larger Atom

### Increasing Atomic Radius

DOWN THE GROUP

ACROSS (R - L) THE PERIOD

New shells are being added.      Electrons in the same shell but the # protons decrease.

Valence electrons have are **farther away** from the nucleus...      This decreases the positive pull on the **electrons**.

This **increases the distance** between the valence shell and nucleus.      Allowing the electrons to slightly drift away from the nucleus.

### Trend 2 Ionization Energy

The **energy** needed to remove an electron from the valence (outermost) shell.

Group 2A

12
<b>Mg</b>
Magnesium
24.31
Alkaline Earth

### Trend 2 Ionization Energy

Increasing Ionization Energy

### Increasing Ionization Energy

UP THE GROUP

ACROSS (L - R) THE PERIOD

Shells are being taken away.      Electrons in the same shell but the # protons increase.

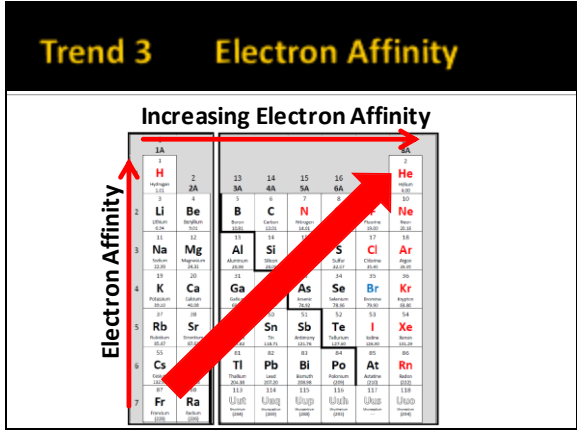
Shells are closer to the **nucleus** ...      This increases the positive pull on the **electrons** ...

Increasing the amount of energy needed to remove an electron.      This increases the amount of energy needed to remove an electron.

### Trend 3 Electron Affinity

Affinity = An Attraction or "Liking"

The ability to **ATTRACT** and **HOLD** an electron.



### Increasing Electron Affinity

**UP THE GROUP**

Shells are being taken away.

Shells are closer to the nucleus increasing the force of attraction...

This increases the amount of energy released when an electron is added.

**ACROSS (L-R) THE PERIOD**

Electrons increase in the shells.

Nonmetals tend to gain electrons to fill octet.

**Whereas...**

Metals tend to lose electrons to fill octet.