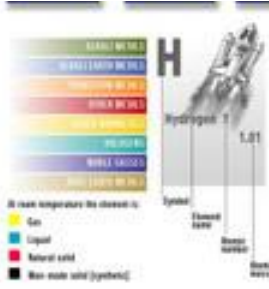


The Periodic Table

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DMITRI MENDELEYEV (1834 - 1907)

The Russian chemist, Dmitri Mendeleev, was the first to observe that if elements were listed in order of atomic mass, they showed regular (periodical)-repeating properties. He formulated his discovery in a periodic table of elements, now regarded as the backbone of modern chemistry.

The outstanding achievement of Mendeleev's periodic table lay in his grouping of then, unclassified elements. In 1869, the year he published his periodic classification, the elements gallium, germanium and scandium were unknown. Mendeleev left spaces for them in his table and even predicted their atomic masses and other chemical properties. Six years later, gallium was discovered and his predictions were found to be accurate. Other discoveries followed and their chemical behaviour matched that predicted by Mendeleev.



This remarkable man, the youngest in a family of 17 children, has left the scientific community with a classification system so powerful that it became the cornerstone in chemistry teaching and the prediction of new elements ever since. In 1955, element 101 was named after him: Md, Mendelevium.

H Hydrogen 1.01

Li Lithium 3
6.94

Be Beryllium 4
9.01

Mg Magnesium 12
24.31

Na Sodium 11
22.99

K Potassium 19
39.10

Ca Calcium 20
40.08

Rb Rubidium 37
85.47

Cs Cesium 55
132.91

Fr Francium 87
[223]

Sc Scandium 21 44.96	Ti Titanium 22 47.88	V Vanadium 23 50.94	Cr Chromium 24 52.00	Mn Manganese 25 54.94	Fe Iron 26 55.85	Co Cobalt 27 58.93	Ni Nickel 28 58.69	Cu Copper 29 63.55	Zn Zinc 30 65.39	Ga Gallium 31 69.72	Ge Germanium 32 72.61	As Arsenic 33 74.92	Se Selenium 34 78.96	Br Bromine 35 79.90	Kr Krypton 36 83.80						
Y Yttrium 39 88.91	Zr Zirconium 40 91.22	Nb Niobium 41 92.91	Mo Molybdenum 42 95.94	Tc Technetium 43 (98)	Ru Ruthenium 44 101.07	Rh Rhodium 45 102.91	Pd Palladium 46 106.42	Ag Silver 47 107.87	Cd Cadmium 48 112.41	In Indium 49 114.82	Sn Tin 50 118.71	Sb Antimony 51 121.76	Te Tellurium 52 127.60	I Iodine 53 126.90	Xe Xenon 54 131.29						
Ba Barium 56 137.33	Hf Hafnium 72 178.49	Ta Tantalum 73 180.95	W Tungsten 74 183.85	Re Rhenium 75 186.21	Os Osmium 76 190.23	Ir Iridium 77 192.22	Pt Platinum 78 195.08	Au Gold 79 196.97	Hg Mercury 80 200.59	Tl Thallium 81 204.38	Pb Lead 82 207.20	Bi Bismuth 83 208.98	Po Polonium 84 (209)	At Astatine 85 (210)	Rn Radon 86 (222)						
Ra Radium 88 (226)	Rf Rutherfordium 104 (261)	Db Dubnium 105 (262)	Sg Seaborgium 106 (263)	Bh Bohrium 107 (264)	Hs Hassium 108 (265)	Mt Meitnerium 109 (266)	La Lanthanum 57 138.91	Ce Cerium 58 140.12	Pr Praseodymium 59 140.91	Nd Neodymium 60 144.24	Pm Promethium 61 (145)	Sm Samarium 62 150.36	Eu Europium 63 151.96	Gd Gadolinium 64 157.25	Tb Terbium 65 158.93	Dy Dysprosium 66 162.50	Ho Holmium 67 164.93	Er Erbium 68 167.26	Tm Thulium 69 168.93	Yb Ytterbium 70 173.05	Lu Lutetium 71 174.97
							Ac Actinium 89 (227)	Th Thorium 90 232.04	Pa Protactinium 91 231.04	U Uranium 92 238.03	Np Neptunium 93 (237)	Pu Plutonium 94 (244)	Am Americium 95 (243)	Cm Curium 96 (247)	Bk Berkelium 97 (247)	Cf Californium 98 (251)	Es Einsteinium 99 (252)	Fm Fermium 100 (257)	Md Mendelevium 101 (258)	No Nobelium 102 (259)	Lr Lawrencium 103 (260)



Early Thoughts

- **Dobereiner** – arranged elements with similar chemical properties into triads.
- **Newlands**- arranged elements by increasing atomic mass. Came up with groups of 8 called them octaves.

Early Thoughts (continued)

- **Mendeleev** – Arranged elements by atomic mass
- **Moseley** - discovered each element had a unique positive charge in the nucleus – Atomic number.

Useful Terms

- **Groups or families** – the vertical columns on the periodic table
- **Periods** – The horizontal rows of the periodic table
- **Valence Electrons** – electrons in the highest principal energy level.

- <http://www.ptable.com/#Writeup/Wikipedia>

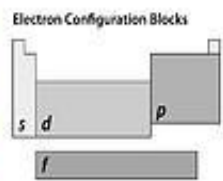
Periodic Table of the Elements

GROUP 1	PERIODIC TABLE OF THE ELEMENTS																GROUP 18			
1																	2			
1	H hydrogen (1.007 - 1.009)																	2	He helium 4.003	
2	Li lithium (6.941 - 6.997)	Be beryllium 9.012																	2	Ne neon 20.18
3	Na sodium 22.99	Mg magnesium 24.31																	3	Ar argon 39.95
4	K potassium 39.10	Ca calcium 40.08	Sc scandium 44.96	Ti titanium 47.87	V vanadium 50.94	Cr chromium 52.00	Mn manganese 54.94	Fe iron 55.85	Co cobalt 58.93	Ni nickel 58.69	Cu copper 63.55	Zn zinc 65.38	Ga gallium 69.72	Ge germanium 72.63	As arsenic 74.92	Se selenium 78.96	Br bromine 79.90	Kr krypton 83.80		
5	Rb rubidium 85.47	Sr strontium 87.62	Y yttrium 88.91	Zr zirconium 91.22	Nb niobium 92.91	Mo molybdenum 95.94	Tc technetium (98)	Ru ruthenium 101.1	Rh rhodium 102.9	Pd palladium 106.4	Ag silver 107.9	Cd cadmium 112.4	In indium 114.8	Sn tin 118.7	Sb antimony 121.8	Te tellurium 127.6	I iodine 126.9	Xe xenon 131.3		
6	Cs caesium 132.9	Ba barium 137.3	lanthanoids	Hf hafnium 178.5	Ta tantalum 180.9	W tungsten 183.8	Re rhenium 186.2	Os osmium 190.2	Ir iridium 192.2	Pt platinum 195.1	Au gold 197.0	Hg mercury 200.6	Tl thallium (204.3 - 204.4)	Pb lead 207.2	Bi bismuth 208.9	Po polonium (210)	At astatine (210)	Rn radon (222)		
7	Fr francium (223)	Ra radium (226)	actinoids	Rf rutherfordium (261)	Db dubnium (264)	Sg seaborgium (266)	Bh bohrium (264)	Hs hassium (277)	Mt meitnerium (268)	Ds darmstadtium (271)	Rg roentgenium (272)	Cn copernicium (285)	Uut ununtrium (284)	Uuq ununquadium (289)	Uup ununpentium (288)	Uuh ununhexium (292)	Uus ununseptium (292)	Uuo ununoctium (294)		

atomic number → 26
 white box = gas state at 0 °C
 chemical symbol → **Fe**
 chemical name → iron
 standard atomic weight (lower - upper bounds) (shown if no stable isotopes) → 55.85

Element Categories

- alkali metals
- alkaline metals
- other metals
- transition metals
- lanthanoids
- actinoids
- metalloids
- nonmetals
- halogens
- noble gases
- unknown elements



Natural Occurrence

- primordial
- from decay
- synthetic

57 La lanthanum 138.9	58 Ce cerium 140.1	59 Pr praseodymium 140.9	60 Nd neodymium 144.2	61 Pm promethium (145)	62 Sm samarium 150.4	63 Eu europium 151.9	64 Gd gadolinium 157.3	65 Tb terbium 158.9	66 Dy dysprosium 162.5	67 Ho holmium 164.9	68 Er erbium 167.3	69 Tm thulium 168.9	70 Yb ytterbium 173.1	71 Lu lutetium 175.0
89 Ac actinium (227)	90 Th thorium 232.0	91 Pa protactinium 231.0	92 U uranium 238.0	93 Np neptunium (237)	94 Pu plutonium (244)	95 Am americium (243)	96 Cm curium (247)	97 Bk berkelium (247)	98 Cf californium (251)	99 Es einsteinium (252)	100 Fm fermium (257)	101 Md mendelevium (258)	102 No nobelium (259)	103 Lr lawrencium (262)

Mendeleev Song... get ready!

- <http://www.bing.com/videos/search?q=Mendeleev+Periodic+Table+Song&FORM=REESTAB&adlt=strict#view=detail&mid=D6CFCA6D88CA4A1FD322D6CFCA6D88CA4A1FD322>

Periodic Law

- **Periodic Law** – When elements are arranged in order of increasing **atomic numbers**, their physical and chemical properties show a periodic pattern.

- **Periodic Trends**-Allow us to see the relationships between the elements and their position on the periodic table
- Such as...
 - http://www.youtube.com/watch?v=QSZ-3wScePM&feature=player_embedded

Valence Electrons

- Elements in a group have the **SAME** number of valence electrons
- s and p blocks
 - s blocks have the same number of valence electrons as their group number
 - p blocks have the same number of valence electrons as the ONES place of their group number
- d block and f block (most)
 - have two valence electrons

This explains it all...

- **Electron shielding** – as you look down a group there are more energy levels, this *blocks* the outer electrons from the nucleus
- **Nuclear affect** – as you look across a period electron configurations have the same highest energy level and more protons. Makes the nuclear attraction greater

Atomic Radius

- **Definition** - the size from the center of the atom to the outermost electron.
- **Trends...**
 - **Period (across the table)** the atomic radius DECREASES
 - **Group- (down the table)** the atomic radius INCREASES.
- The largest atomic radius is **Fr**
- The smallest atomic radius is **He**

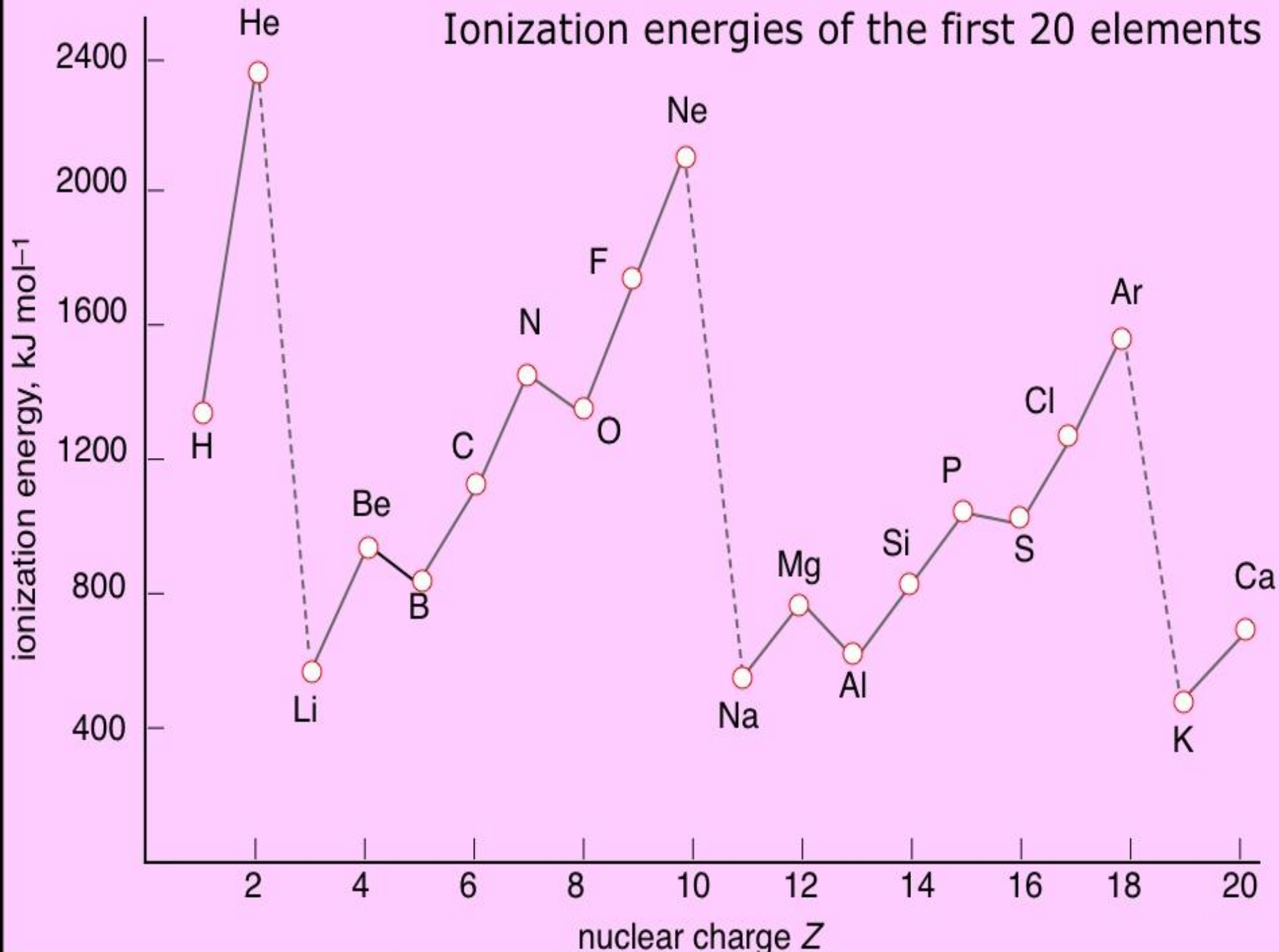
Ion Size

- **Ion-** an atom that has gained or lost one or more electrons
 - All Metals form "+" ions (losers)
 - All Nonmetals form "-" ions (gainers)
 - Elements in a group form ions of the same charge
- **Trend...**
 - "+" ions are smaller than their corresponding atoms
 - "-" ions are larger than their corresponding atoms

Ionization energy

- **Ionization Energy**-Tells us how much energy is required to remove one electron from an atom.
(measured in joules)
 - $A + \text{energy} \rightarrow A^+ + e^-$
- **Trends**
 - **Period**-Increase across the period.
 - **Group**- decreases as you go down the group.

Ionization energies of the first 20 elements



Removing multiple electrons.

- **Example**, Boron [He] $2s^2 2p^1$
- IE_1 801 J, IE_2 2427 J, IE_3 3660 J,
 IE_4 25026 J, IE_5 32827 J
- Where is the big jump in energy and why?
 - Between 3 and 4
 - You lose all the valence electrons and are removing core electrons after IE_3

Electron Affinity

- **Electron Affinity**-The energy change that occurs when an electron is acquired by a neutral atom. Most atoms give off energy when an electron is gained

Electron Affinity trends

- **General**

- Metals have a low E.A.
- Nonmetals have a high E.A.

- **Period** - as you move across the period, the electron affinity increases until you reach the halogens.

- **Group** - As you move down a group, the electron affinity decreases.

IA
1VIIIA
18

Electron affinities in kJ released per mole of mononegative ions formed

											IIIA 13	IVA 14	VA 15	VIA 16	VIIA 17	He -21	
H 73											B 27	C 122	N -7	O 141	F 328	Ne -29	
Li 60	Be -19											Al 43	Si 134	P 72	S 200	Cl 349	Ar -35
Na 53	Mg -19	IIIB 3	IVB 4	VB 5	VIB 6	VII B 7	VIII 8	VIII 9	VIII 10	IB 11	II B 12	Ga 29	Ge 116	As 78	Se 195	Br 325	Kr -39
K 48	Ca -10	Sc 18	Ti 8	V 51	Cr 64	Mn	Fe 16	Co 64	Ni 112	Cu 118	Zn -47	In 29	Sn 116	Sb 103	Te 190	I 295	Xe -41
Rb 47	Sr	Y 30	Zr 41	Nb 86	Mo 72	Tc 53	Ru 101	Rh 110	Pd 54	Ag 126	Cd -32	Tl 20	Pb 35	Bi 91	Po 183	At 270	Rn -41
Cs 45	Ba	La	Hf	Ta 31	W 79	Re 14	Os 106	Ir 101	Pt 205	Au 223	Hg -61						
Fr 44	Ra	Ac	Db	Jl	Rf	Bh	Hn	Mt									

Electronegativity

- **Definition** - the ability of an atom in a molecule to attract electrons to itself
- **Trends**
 - **Period** - increases across the period. The metals tend to give electrons away rather than attract them.
 - **Group Trend**- decreases or stays about the same
- Noble gases aren't electronegative
- **F** is the most electronegative element.

Humor: On the Fun Side

“What elements think of each other, a conversation between elements.”

