

History of the Periodic Table

- Many scientists suspected a pattern in the order of the elements, but were not able to exactly figure it out.
- Dmitri Mendeleev was the first to create an accurate arrangement of the known elements based on <u>atomic mass</u>.

Ueber die Beziehungen der Eigenschaften zu den Atomgewichten der Elemente. Von D. Mendelejeff. — Ordnet man Elemente nach zunehmenden Atomgewichten in verticale Reihen so, dass die Horizontalreihen analoge Elemente enthalten, wieder nach zunehmendem Atomgewicht geordnet, so erhält man folgende Zusammenstellung, aus der sich einige allgemeinere Folgerungen ableiten lassen.

```
Zr = 90
Nb = 94
                                                        Ta = 182
                                V = 51
                               Cr = 52
                                           Mo = 96
                                                         W = 186
                               Mn = 55
                                           Rh == 104,4
                                                         Pt = 197,4
                                                         Ir == 198
                               Fe = 56
                                           Ru = 104,4
                         Ni - Co - 59
                                           Pd == 106,6
                                                        0s = 199
                               Cu = 63.4
                                          Ag = 108

Cd = 112
                                                        Hg - 200
                               Zn = 65.2
                                                        Au - 197?
                                ? = 68
                                            Ur - 116
        B = 11
                                 ? = 70
                                            Sn == 118
                                                        Bi == 210?
                    P = 31
                               As = 75
                                            Sb = 122
                                           Te == 128?
                               Se = 79,4
                               Br = 80
                                             J == 127
                               Rb = 85,4
                                           Cs = 133
                                                         T1 = 204
Li = 7 Na = 23
                                                        Pb == 207
                               Sr = 87,6
                                           Ba === 137
                               Ce = 92
                  ?Er = 56
                               Di = 95
                  ?Yt = 60
                  ?In = 75,6 Th = 118?
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 Die nach der Grösse des Atomgewichts geordneten Elemente zeigen eine stufenweise Abanderung in den Eigenschaften.

 Chemisch-analoge Elemente haben entweder übereinstimmende Atomgewichte (Pt, Ir, Os), oder letztere nehmen gleichviel zu (K, Rb, Cs).
 Das Anordnen nach den Atomgewichten entspricht der Werthigkeit

3. Das Anordnen nach den Atomgewichten entspricht der Werthigkeit der Elemente und bis zu einem gewissen Grade der Verschiedenheit im chemischen Verhalten, z. B. Li, Be, B, C, N, O, F.

4. Die in der Natur verbreitetsten Elemente haben kleine Atomgewichte

Mendeleev's Periodic Table, published in Zeitschrift für Chemie, 1869.

- Mendeleev was actually able to predict the existence of elements that didn't exist yet, based just on missing spaces in the patterns he saw on his periodic table.
 - Accurately predicted the actual properties of four of those undiscovered elements, including gallium, scandium, technetium, and germanium.

	Predicted Element	Actual Element
Name	Eka-Aluminum	Gallium
Density	6.0 g/cm ³	5.9 g/cm ³
Melting Point	Low	29.78C
Compound made with oxygen	Ea ₂ O ₃	Ga ₂ O ₃

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$$H = 1 \\ Be = 9.4 \\ N = 12 \\ Be = 11 \\ N = 14 \\ R = 14 \\ R = 19 \\$$

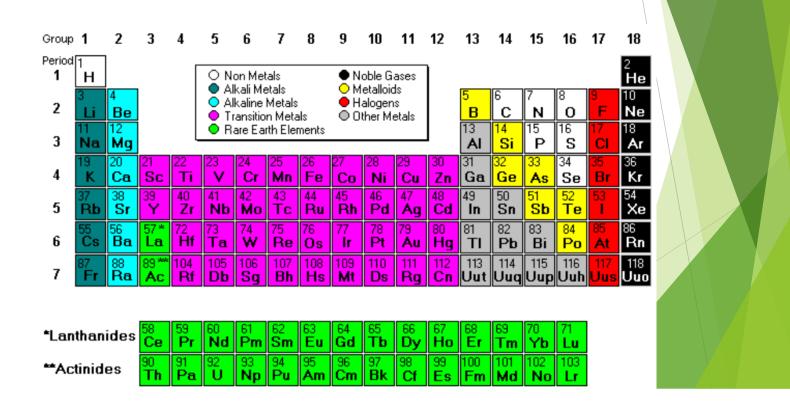
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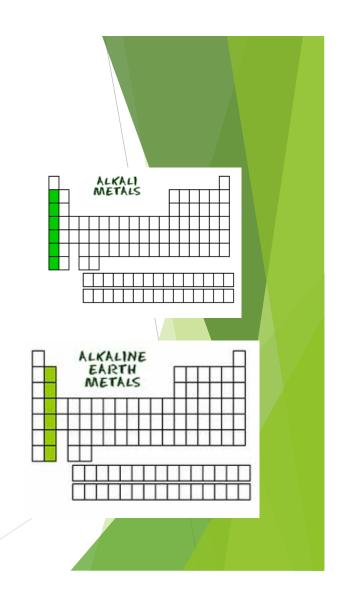
Mendeleev's Periodic Table, published in Zeitschrift für Chemie, 1869.

- Today, the periodic table is divided into a series of horizontal periods and vertical groups or families.
- ► Elements within a period or family will follow certain general trends, or have specific properties in common.

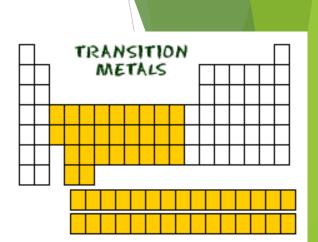


Periodic Table Groups

- ▶ Alkali metals occupy group 1.
 - One valence electron.
 - ▶ Highly reactive.
 - ▶ Rarely found in nature as pure elements.
- ▶ Alkaline earth metals occupy group 2.
 - ► Two valence electrons.
 - ▶ Reactive, but not as much as the alkali metals.
 - ▶ All are found in nature.

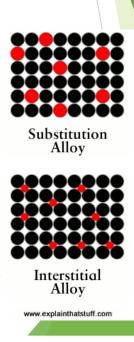


- ► Transition metals occupy groups 3-12.
 - ▶ Also referred to as the "d-block" because their electrons fill in the d sublevels.
 - ► Can form more than one ion due to the high number of dsublevel electrons.
 - ▶ Able to form a wide variety of different colored compounds.
 - ► The bottom two rows, removed from the periodic table, are also called **rare earth metals**.





- Each of these groups contain metals, which all have a common set of properties:
 - Usually solid, with a high melting and boiling point.
 - Exceptions: Mercury (Hg) and Gallium (Ga) are liquids.
 - ▶ Malleable, meaning they can be hammered into thin sheets.
 - **Ductile**, meaning they can be drawn or twisted into wires.
 - ▶ Conductive, meaning they can transport electrons and heat.
- Some metals can be combined with other elements to produce alloys.
 - ► Alloys are technically mixtures, but may have better properties (stronger, resistant to corrosion) than their parent metal.



Common alloys include:

▶ Amalgam: Mercury + silver, tin, copper, and zinc.

▶ Brass: Copper + zinc.

▶ Bronze: Copper + tin.

▶ Stainless Steel: Iron + chromium and carbon.

► Sterling silver: Silver + copper

▶ White gold: Gold + palladium, silver, and copper.

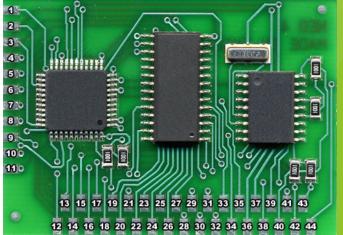


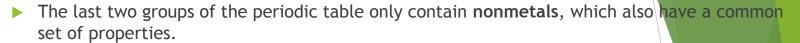




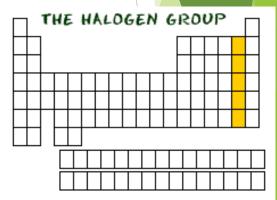
- ► The next four groups are named after the element at the top.
 - ▶ Group 13 is the boron family
 - ▶ Group 14 is the carbon family.
 - ▶ Group 15 is the nitrogen family.
 - ► Group 16 is the oxygen family.
- ► The boron family has the first metalloid on the periodic table.
- ▶ **Metalloids** have properties in between those of metals and nonmetals.
 - ► Example: They are electrical **semiconductors**, meaning they conduct electricity under some conditions, but not others.



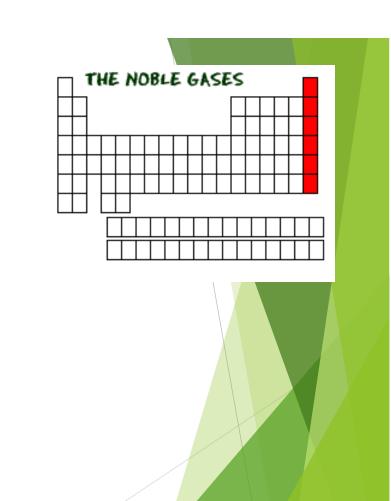




- ▶ They can be solids, liquids, or gases at room temperature.
- ▶ Boiling and melting points are lower than metals.
- ▶ They do not conduct electricity or heat well.
- ▶ Solid nonmetals are usually brittle, and do not have a luster.
- ► The halogens occupy group 17.
 - Seven valence electrons.
 - Reactive.
 - ► Also called "salt-formers", because they combine with various metals to produce salts.

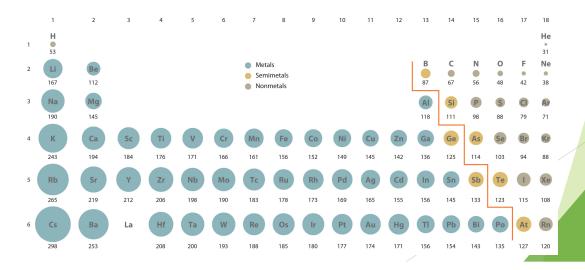


- ► Group 18 is the **noble gases**.
 - ▶ All are gases at room temperature.
 - ► Each has a full outer shell of valence electrons (2 for helium, 8 for the rest).
 - ▶ Very stable and non-reactive.



Periodic Trends

- Other properties will change in predictable ways as you move across or down the periodic table.
- ▶ Atomic radius is a measurement of how big an atom is.
 - ▶ Increases as you move down a group.
 - ▶ Decreases as you move across a period.



- ▶ Electronegativity and electron affinity measure the ability of an atom to attract and bond to other electrons.
 - ► Increases across a period.
 - ▶ Decreases down a period.

INCREASING ELECTRONEGATIVITY

H H Hydrogen 1,00794																	He
3	4											5	6	7	8	9	10
Li tabase 6.941	Be Replian 9.012182											B 10.811	Carbon 12,0107	N Naogan 14.00674	Oupn 15,9994	F 18,9984032	Ne 20,1797
11	12	f										13	14	15	16	17	18
Na 50dum 22.0093710	Mg											Al 26.981538	Si 56cm 28.0855	P Phosphorus 30.973761	S Salte 32,066	CI (Notes: 35,4527	Ar Arpm 39.948
19	20	21	22	23	. 24	25	26	27	28	29	30	31	32	33	34	35	36
K 20000000 390,0983	Ca Calcium 40,078	Sc 5cmdum 44,955910	Ti Titaniam 47,867	V Vaniden 50.9415	Cr Chronicm 51,5961	Mn Manganose 54.938049	Fe box 55,845	Co 58,933200	Ni Noted 58,4034	Cu Copper 63,546	Zn 65.39	Ga Gallann 69,723	Ge Germanian 72,61	As Attente 24,92160	Se Sciences T8.96	Br teensc 79,904	Kr Stypon 83,80
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
Rb Ratislam 85,4678	Sr Secondary 87.62	Y Yesus 88.90585	Zr 91,224	Nb Notion 92,90638	Mo Mohdenan 95,94	Tc Technorium (98)	Ru Rathenians 101.07	Rh Rhodian 102,90550	Pd Palladuse 106,42	Ag 58hur 107,8682	Cd Caterian 112,411	In interv 114.818	Sn 118,710	Sb Antoning 121,760	Te Tellutum 127,60	I lodes 126,90447	Xe Xence 131.29
55	56	57	72	73	74	75	76	77	.78	79	80	81	82	83	84	85	86
Cs Canada 32,90545	Ba Ration 137,327	La tamboran 138,9055	Hf Holoson 178,49	Ta Tarratum 180,9479	W Tungstern 183,84	Re Rhousen 186,207	Os 190.23	Ir 192.217	Pt Plainer 195,078	Au 196,96655	Hg Starons 200,59	TI Ballian 204,3833	Pb 1304 207.2	Bi fissoh 208.98038	Po (209)	At Attacks (210)	Rn Radeo (222)
87	88	89	104	105	106	107	108	109	110	111	112	113	114		2.202	-22.5	3 3 3 3 3
Fr Function (223)	Ra Radium (226)	Ac Actinium (227)	Rf Retherler down (261)	Db Dubnicas (262)	Sg Sastorpose (263)	Bh Bobrien (262)	Hs (265)	Mt Maintenant (266)	(269)	(272)	(277)	1000000	H30505-3				8

INCREASING ELECTRONEGATIVITY

- lonization energy is the amount of energy needed to remove an electron from a neutral atom.
 - ▶ Increases from left to right.
 - Decreases from top to bottom.
- As you move down a period, the valence electrons become more **shielded** from the nucleus, making them easier to remove.

INCREASING IONIZATION ENERGY

H H Hydrogen 1,00794																	He
3	4	1										5	6	7	- 8	9	10
Li	Be											В	C	N	O	F	Ne
6.941	9.012182											10.811	12.0107	Nacopon 14,00674	15.9994	18,9984032	20.1797
11	12	ľ										13	14	15	16	17	18
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87	88	89	104	105	106	107	108	109	110	111	112	113	114	2000	22.00	-120/05	100000
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