

The Periodic Table

Johann Wolfgang Dobereiner

- * Dobereiner organized known elements into triads based on their similar properties:
- * Li - Na - K
- * Ca - Sr - Ba
- * S - Se - Te
- * Cl - Br - I

John Newlands (1865)

- * Ranked elements by atomic mass
- * Noted that elements with similar properties occurred every 8th element
- * Newlands called this pattern **The Law of Octaves**

Dimitri Mendeleev (1869)

- * Known as the father of the periodic table
- * Assembled the first periodic table by atomic mass
- * Elements with similar properties were placed in columns
- * Left spaces for undiscovered elements and predicted their properties

The Periodic Law

- * When elements are arranged by atomic number, their chemical and physical properties recur periodically.
- * Periods = horizontal rows
- * Groups (Families) = vertical columns contain elements with similar properties.

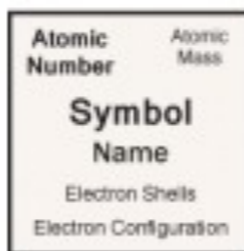
Mendeleev's Predictions

Property	Ekasilicon (predicted 1869)	Germanium (actual 1886)
Atomic mass	72	72.32
Colour	Dark grey	Greyish-white
Density (g/cm ³)	5.5	5.47
Melting point (°C)	High	947
Formula of Oxide	EsO ₂	GeO ₂
Formula of Chloride	EsCl ₄	GeCl ₄

Elements Discovered In Your Lifetime . . .

1 1,008* H idrogeno	2 IIA											13 III A	14 IV A	15 V A	16 VI A	17 VII A	18 VIII A 2 4,003 He elio
3 6,94* Li litio	4 9,012 Be berillio											5 10,81* B boro	6 12,01* C carbonio	7 14,01* N azoto	8 16,00* O ossigeno	9 19,00 F fluoro	10 20,18 Ne neon
11 22,99 Na sodio	12 24,31* Mg magnesio	3 III B	4 IV B	5 V B	6 VI B	7 VII B	8 VIII B	9 VIII B	10 VIII B	11 IB	12 IIB	13 26,98 Al alluminio	14 28,09* Si silicio	15 30,97 P fosforo	16 32,06* S zolfo	17 35,45* Cl cloro	18 39,95 Ar argon
19 39,10 K potassio	20 40,08 Ca calcio	21 44,96 Sc scandio	22 47,87 Ti titanio	23 50,94 V vanadio	24 52,00 Cr cromo	25 54,94 Mn manganese	26 55,85 Fe ferro	27 58,93 Co cobalto	28 58,69 Ni nichel	29 63,55 Cu rame	30 65,38* Zn zinco	31 69,72 Ga gallio	32 72,63 Ge germanio	33 74,92 As arsenico	34 78,96* Se selenio	35 79,90* Br bromo	36 83,80 Kr kripton
37 85,47 Rb rubidio	38 87,62 Sr stronzio	39 88,91 Y ittrio	40 91,22 Zr zirconio	41 92,91 Nb niobio	42 95,96* Mo molibdeno	43 [98] Tc tecnecio	44 101,1 Ru rutenio	45 102,9 Rh rodio	46 106,4 Pd palladio	47 107,9 Ag argento	48 112,4 Cd cadmio	49 114,8 In indio	50 118,7 Sn stagno	51 121,8 Sb antimonio	52 127,6 Te tellurio	53 126,9 I iodio	54 131,3 Xe xeno
55 132,9 Cs cesio	56 137,3 Ba bario	57-71	72 178,5 Hf afnio	73 180,9 Ta tantalio	74 183,8 W tungsteno	75 186,2 Re renio	76 190,2 Os osmio	77 192,2 Ir iridio	78 195,1 Pt platino	79 197,0 Au oro	80 200,6 Hg mercurio	81 204,4* Tl tallio	82 207,2 Pb piombo	83 209,0 Bi bismuto	84 [209] Po polonio	85 [210] At astato	86 [222] Rn radon
87 [223] Fr francio	88 [226] Ra radio	89-103	104 [267] Rf rutherfordio	105 [268] Db dubnio	106 [269] Sg seaborgio	107 [270] Bh bohrio	108 [269] Hs hassio	109 [278] Mt meitnerio	110 [281] Ds darmstadtio	111 [281] Rg roentgenio	112 [285] Cn copernicio	113 [286] Uut ununtrio	114 [289] Fl flerovio	115 [288] Uup ununpentio	116 [293] Lv livermorio	117 [294] Uus ununseptio	118 [294] Uuo ununoctio
*H: [1,00784, 1,00811] Li: [6,938, 6,997] B: [10,806, 10,821] C: [12,0096, 12,0116] N: [14,00643, 14,00728] O: [15,99903, 15,99977] Mg: [24,304, 24,307] Si: [26,084, 26,086] S: [32,059, 32,076] Cl: [35,446, 35,457] Br: [79,901, 79,907] Ti: [204,382, 204,385] Zn: 65,38(2) Se: 78,96(3) Mo: 95,96(2)		57 138,9 La lantanio	58 140,1 Ce cerio	59 140,9 Pr praseodimio	60 144,2 Nd neodimio	61 [145] Pm promezio	62 150,4 Sm samario	63 152,0 Eu europio	64 157,3 Gd gadolinio	65 158,9 Tb terbio	66 162,5 Dy disprozio	67 164,9 Ho olmio	68 167,3 Er erbio	69 168,9 Tm tulio	70 173,1 Yb itterbio	71 175,0 Lu lutezio	
		89 [227] Ac attinio	90 232,0 Th torio	91 231,0 Pa protoattinio	92 238,0 U uranio	93 [237] Np nettunio	94 [244] Pu plutonio	95 [243] Am americio	96 [247] Cm curio	97 [247] Bk berkelio	98 [251] Cf californio	99 [252] Es einsteinio	100 [257] Fm fermio	101 [258] Md mendelevio	102 [259] No nobelio	103 [262] Lr laurenzio	

Periodic Table of the Elements



Element symbol represents state at room temperature.

Solid, Liquid or Gas

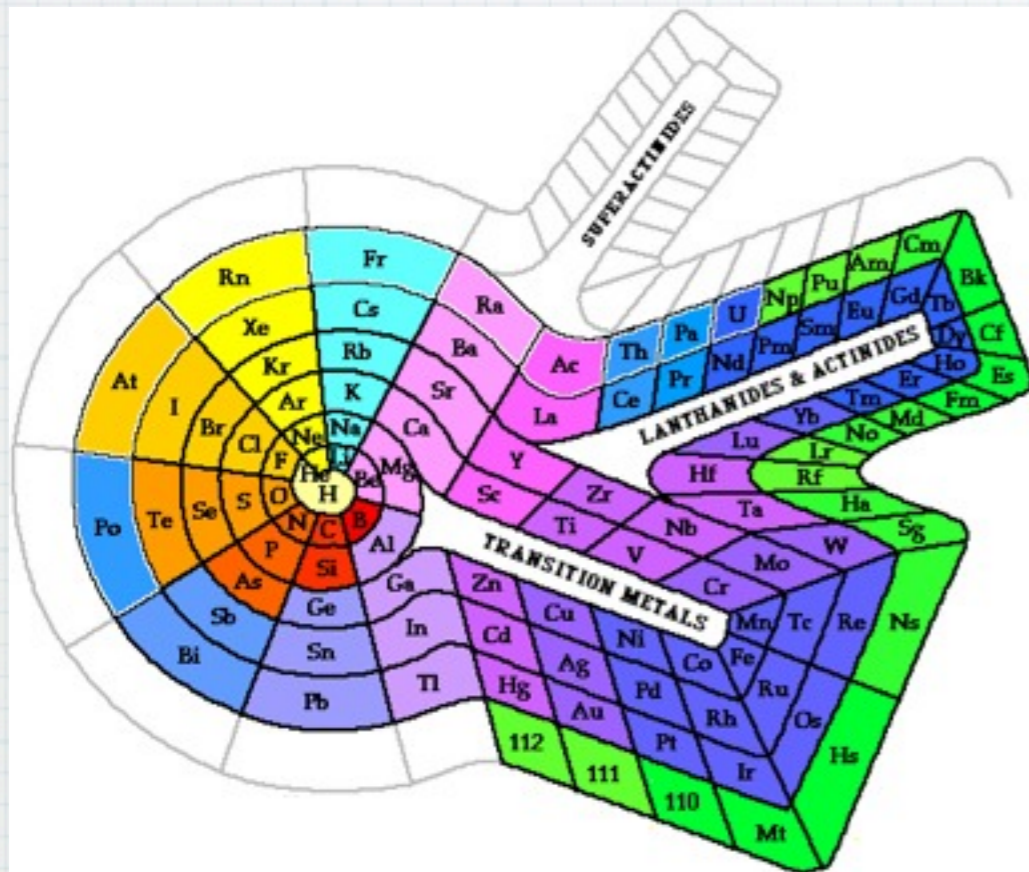
1 1A 1A 1 H Hydrogen 1.008 1s ¹	2 IIA 2A 4 Be Beryllium 9.012 [He]s ²	3 IIIB 3B 11 Na Sodium 22.990 [Ne]3s ¹	4 IVB 4B 12 Mg Magnesium 24.305 [Ne]3s ²	5 VB 5B 21 Sc Scandium 44.956 [Ar]3d ¹ 4s ²	6 VIB 6B 22 Ti Titanium 47.88 [Ar]3d ² 4s ²	7 VIIB 7B 23 V Vanadium 50.942 [Ar]3d ³ 4s ²	8 VIII 8 24 Cr Chromium 51.996 [Ar]3d ⁵ 4s ¹	9 VIII 8 25 Mn Manganese 54.938 [Ar]3d ⁵ 4s ²	10 VIII 8 26 Fe Iron 55.845 [Ar]3d ⁶ 4s ²	11 IB 1B 27 Co Cobalt 58.933 [Ar]3d ⁷ 4s ²	12 IIB 2B 28 Ni Nickel 58.693 [Ar]3d ⁸ 4s ²	13 IIIA 3A 29 Cu Copper 63.546 [Ar]3d ¹⁰ 4s ¹	14 IVA 4A 30 Zn Zinc 65.38 [Ar]3d ¹⁰ 4s ²	5 10.811 13 Al Aluminum 26.982 [Ne]3s ² 3p ¹	6 12.011 14 C Carbon 28.086 [He]2s ² 2p ²	7 14.007 15 N Nitrogen 30.974 [He]2s ² 2p ³	8 15.999 16 O Oxygen 32.066 [He]2s ² 2p ⁴	9 18.998 17 F Fluorine 35.453 [He]2s ² 2p ⁵	10 20.180 18 Ne Neon 39.948 [He]2s ² 2p ⁶
19 39.098 37 K Potassium 2 8 8 1 [Ar]4s ¹	20 40.078 38 Ca Calcium 2 8 8 2 [Ar]4s ²	21 44.956 39 Sc Scandium 2 8 9 2 [Ar]3d ¹ 4s ²	22 47.88 40 Ti Titanium 2 8 10 2 [Ar]3d ² 4s ²	23 50.942 41 V Vanadium 2 8 11 2 [Ar]3d ³ 4s ²	24 51.996 42 Cr Chromium 2 8 13 1 [Ar]3d ⁵ 4s ¹	25 54.938 43 Mn Manganese 2 8 13 2 [Ar]3d ⁵ 4s ²	26 55.845 44 Fe Iron 2 8 14 2 [Ar]3d ⁶ 4s ²	27 58.933 45 Co Cobalt 2 8 15 2 [Ar]3d ⁷ 4s ²	28 58.693 46 Ni Nickel 2 8 16 2 [Ar]3d ⁸ 4s ²	29 63.546 47 Cu Copper 2 8 18 1 [Ar]3d ¹⁰ 4s ¹	30 65.38 48 Zn Zinc 2 8 18 2 [Ar]3d ¹⁰ 4s ²	31 69.723 49 Ga Gallium 2 8 18 3 [Ar]3d ¹⁰ 4s ² 4p ¹	32 72.631 50 Ge Germanium 2 8 18 4 [Ar]3d ¹⁰ 4s ² 4p ²	33 74.922 51 As Arsenic 2 8 18 5 [Ar]3d ¹⁰ 4s ² 4p ³	34 78.971 52 Se Selenium 2 8 18 6 [Ar]3d ¹⁰ 4s ² 4p ⁴	35 79.904 53 Br Bromine 2 8 18 7 [Ar]3d ¹⁰ 4s ² 4p ⁵	36 84.796 54 Kr Krypton 2 8 18 8 [Ar]3d ¹⁰ 4s ² 4p ⁶		
55 132.905 87 Fr Francium 2 8 18 32 18 8 1 [Rn]7s ¹	56 137.328 88 Ra Radium 2 8 18 32 18 8 2 [Rn]7s ²	57-71 Lanthanide Series	72 178.49 104 Rf Rutherfordium 2 8 18 32 10 2 [Xe]4f ¹⁴ 5d ² 6s ²	73 180.948 105 Db Dubnium 2 8 18 32 11 2 [Xe]4f ¹⁴ 5d ³ 6s ²	74 183.84 106 Sg Seaborgium 2 8 18 32 12 2 [Xe]4f ¹⁴ 5d ⁴ 6s ²	75 186.207 107 Bh Bohrium 2 8 18 32 13 2 [Xe]4f ¹⁴ 5d ⁵ 6s ²	76 190.23 108 Hs Hassium 2 8 18 32 14 2 [Xe]4f ¹⁴ 5d ⁶ 6s ²	77 192.217 109 Mt Meitnerium 2 8 18 32 15 2 [Xe]4f ¹⁴ 5d ⁷ 6s ²	78 195.085 110 Ds Darmstadtium 2 8 18 32 16 2 [Xe]4f ¹⁴ 5d ⁸ 6s ²	79 196.967 111 Rg Roentgenium 2 8 18 32 17 2 [Xe]4f ¹⁴ 5d ⁹ 6s ²	80 200.592 112 Cn Copernicium 2 8 18 32 18 2 [Xe]4f ¹⁴ 5d ¹⁰ 6s ²	81 204.383 113 Uut Ununtrium 2 8 18 32 18 3 [Xe]4f ¹⁴ 5d ¹⁰ 6s ² 6p ¹	82 207.2 114 Fl Flerovium 2 8 18 32 18 4 [Xe]4f ¹⁴ 5d ¹⁰ 6s ² 6p ²	83 208.980 115 Uup Ununpentium 2 8 18 32 18 5 [Xe]4f ¹⁴ 5d ¹⁰ 6s ² 6p ³	84 [208.982] 116 Lv Livermorium 2 8 18 32 18 6 [Xe]4f ¹⁴ 5d ¹⁰ 6s ² 6p ⁴	85 209.987 117 Uus Ununseptium 2 8 18 32 18 7 [Xe]4f ¹⁴ 5d ¹⁰ 6s ² 6p ⁵	86 222.018 118 Uuo Ununoctium 2 8 18 32 18 8 [Xe]4f ¹⁴ 5d ¹⁰ 6s ² 6p ⁶		

57 138.905 La Lanthanum 2 8 18 18 9 2 [Xe]5d ¹ 6s ²	58 140.116 Ce Cerium 2 8 18 20 8 2 [Xe]4f ¹ 5d ¹ 6s ²	59 140.908 Pr Praseodymium 2 8 18 21 8 2 [Xe]4f ³ 6s ²	60 144.243 Nd Neodymium 2 8 18 22 8 2 [Xe]4f ⁴ 6s ²	61 144.913 Pm Promethium 2 8 18 23 8 2 [Xe]4f ⁵ 6s ²	62 150.36 Sm Samarium 2 8 18 24 8 2 [Xe]4f ⁶ 6s ²	63 151.964 Eu Europium 2 8 18 25 8 2 [Xe]4f ⁷ 6s ²	64 157.25 Gd Gadolinium 2 8 18 25 9 2 [Xe]4f ⁷ 5d ¹ 6s ²	65 158.925 Tb Terbium 2 8 18 27 8 2 [Xe]4f ⁹ 6s ²	66 162.500 Dy Dysprosium 2 8 18 28 8 2 [Xe]4f ¹⁰ 6s ²	67 164.930 Ho Holmium 2 8 18 29 8 2 [Xe]4f ¹¹ 6s ²	68 167.259 Er Erbium 2 8 18 30 8 2 [Xe]4f ¹² 6s ²	69 168.934 Tm Thulium 2 8 18 31 8 2 [Xe]4f ¹³ 6s ²	70 173.055 Yb Ytterbium 2 8 18 32 8 2 [Xe]4f ¹⁴ 6s ²	71 174.967 Lu Lutetium 2 8 18 32 9 2 [Xe]4f ¹⁴ 5d ¹ 6s ²
89 227.028 Ac Actinium 2 8 18 32 18 9 2 [Xe]6s ² 7s ²	90 232.038 Th Thorium 2 8 18 32 18 10 2 [Xe]6s ² 7s ²	91 231.036 Pa Protactinium 2 8 18 32 18 9 3 [Xe]5f ² 6s ² 7s ²	92 238.029 U Uranium 2 8 18 32 21 9 2 [Xe]5f ³ 6s ² 7s ²	93 237.048 Np Neptunium 2 8 18 32 23 8 2 [Xe]5f ⁴ 6s ² 7s ²	94 244.064 Pu Plutonium 2 8 18 32 24 8 2 [Xe]5f ⁶ 6s ² 7s ²	95 243.061 Am Americium 2 8 18 32 25 8 2 [Xe]5f ⁷ 6s ² 7s ²	96 247.070 Cm Curium 2 8 18 32 25 9 2 [Xe]5f ⁷ 6s ² 7s ²	97 247.070 Bk Berkelium 2 8 18 32 27 8 2 [Xe]5f ⁹ 6s ² 7s ²	98 251.080 Cf Californium 2 8 18 32 28 8 2 [Xe]5f ¹⁰ 6s ² 7s ²	99 [254] Es Einsteinium 2 8 18 32 28 9 2 [Xe]5f ¹¹ 6s ² 7s ²	100 257.095 Fm Fermium 2 8 18 32 30 8 2 [Xe]5f ¹² 6s ² 7s ²	101 258.1 Md Mendelevium 2 8 18 32 31 8 2 [Xe]5f ¹³ 6s ² 7s ²	102 259.101 No Nobelium 2 8 18 32 32 8 2 [Xe]5f ¹⁴ 6s ² 7s ²	103 [262] Lr Lawrencium 2 8 18 32 32 9 2 [Xe]5f ¹⁴ 6s ² 7s ²

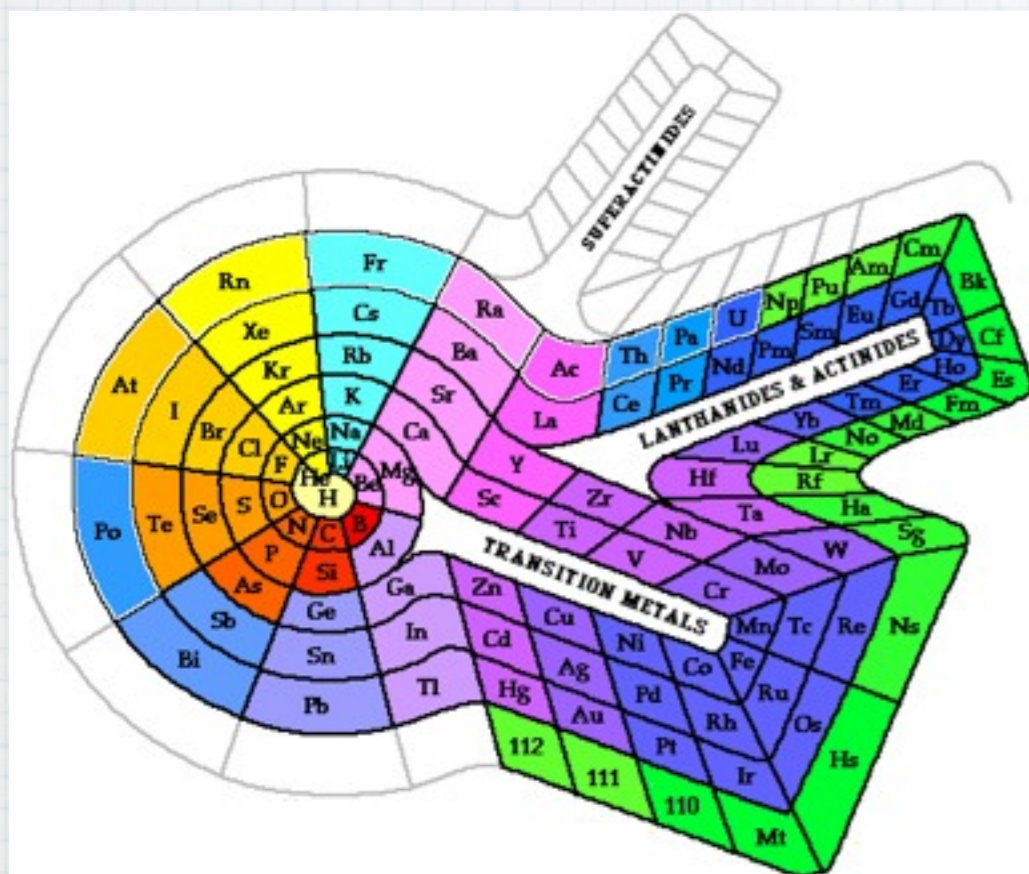
- Alkali Metal
- Alkaline Earth
- Transition Metal
- Basic Metal
- Metalloid
- Nonmetal
- Halogen
- Noble Gas
- Lanthanide
- Actinide

Alternate Periodic Tables:

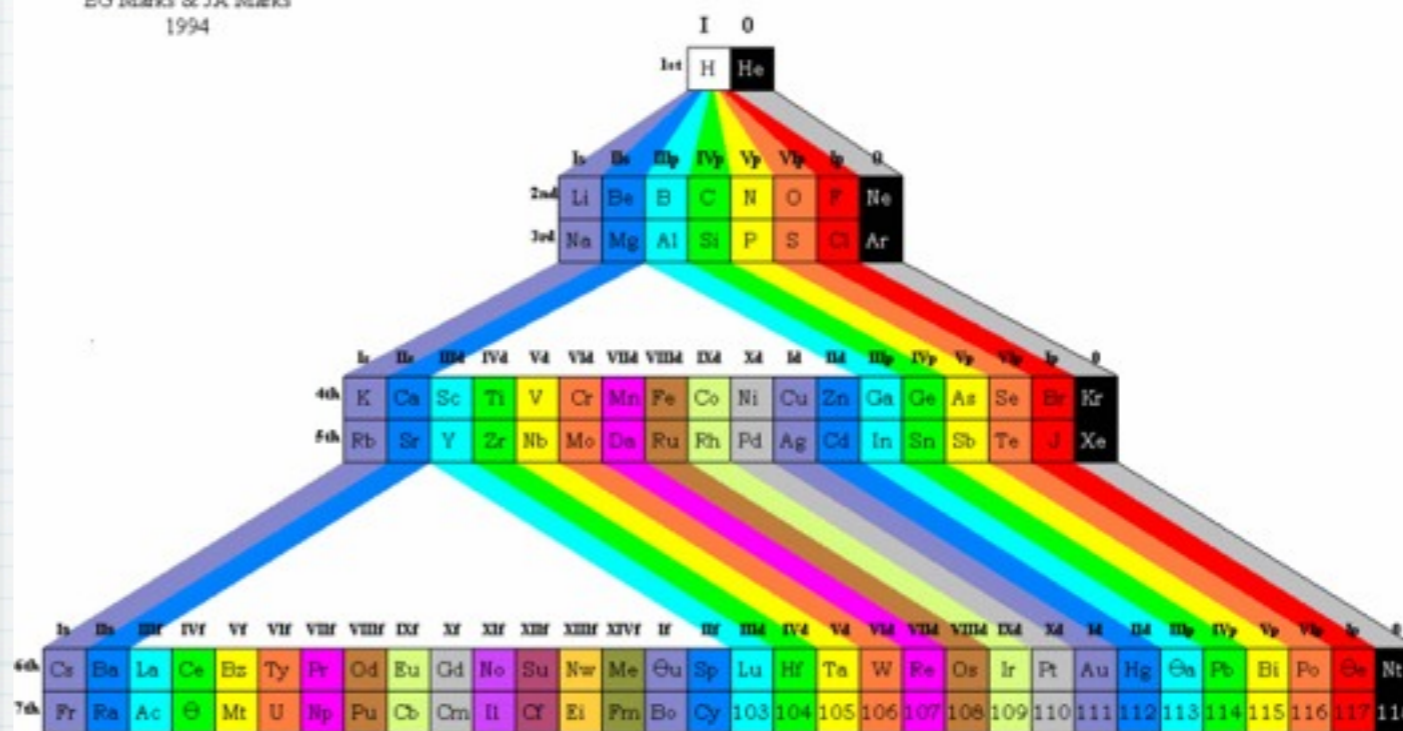
Alternate Periodic Tables:



Alternate Periodic Tables:



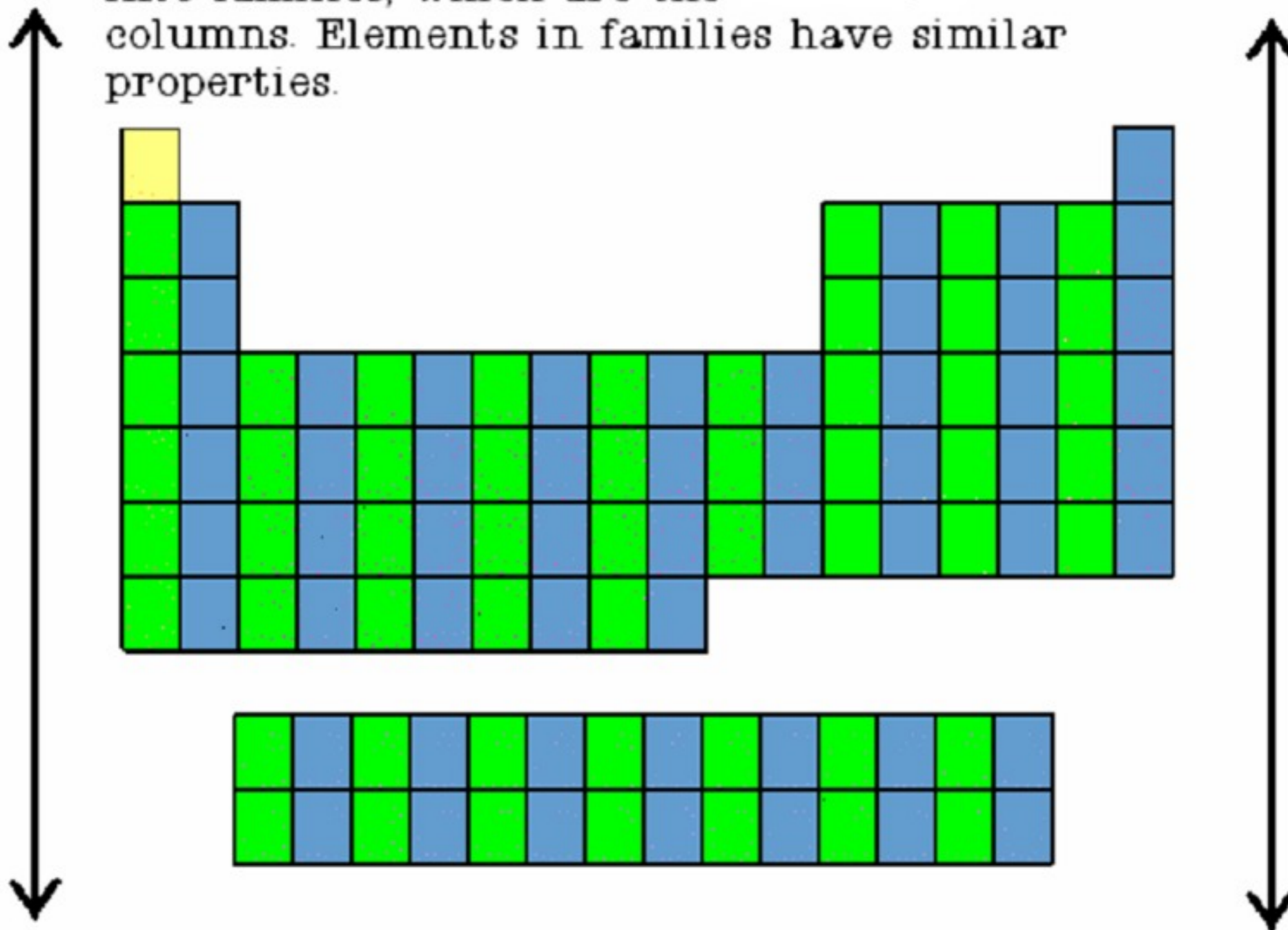
PERIODIC TABLE
EG Marks & JA Marks
1994



Periodic Table Arrangement

- * The periodic table arranges elements by:
- * Into vertical columns called groups – group number tells the number of electrons in the outermost shell ie the number of valence electrons. There are 18 groups

Elements in the periodic table are also grouped into families, which are the columns. Elements in families have similar properties.



Periodic Table Arrangement

- * The periodic table arranges elements by:
- * Into horizontal rows called periods.
- * Period tells the number of shells or energy level.
- * There are 7 periods

Group 1: The Alkali Metals

- * Elements: Li, Na, K, Rb, Cs, Fr
- * Very reactive
- * Shared Physical Properties:
 - * Soft solids at room temp.
 - * Malleable
 - * Ductile
 - * Good conductors of heat/electricity



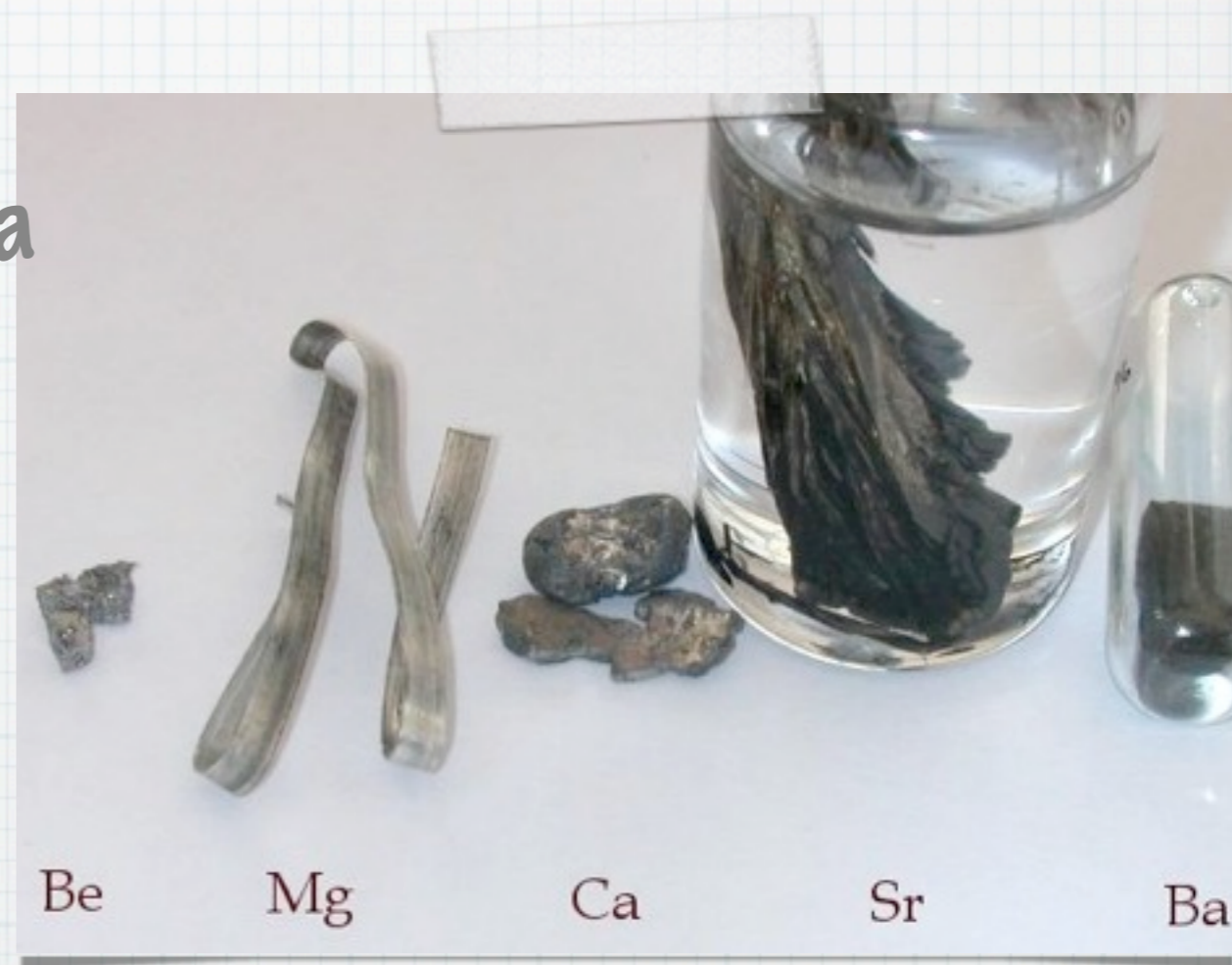
Group 1: The Alkali Metals

- * Very reactive metals that do not occur freely in nature.
- * Have only one electron in their outer shell.
- * Ready to lose that one electron in ionic bonding with other elements. Follows the octet rule.
- * Has a valency of 1^+ .



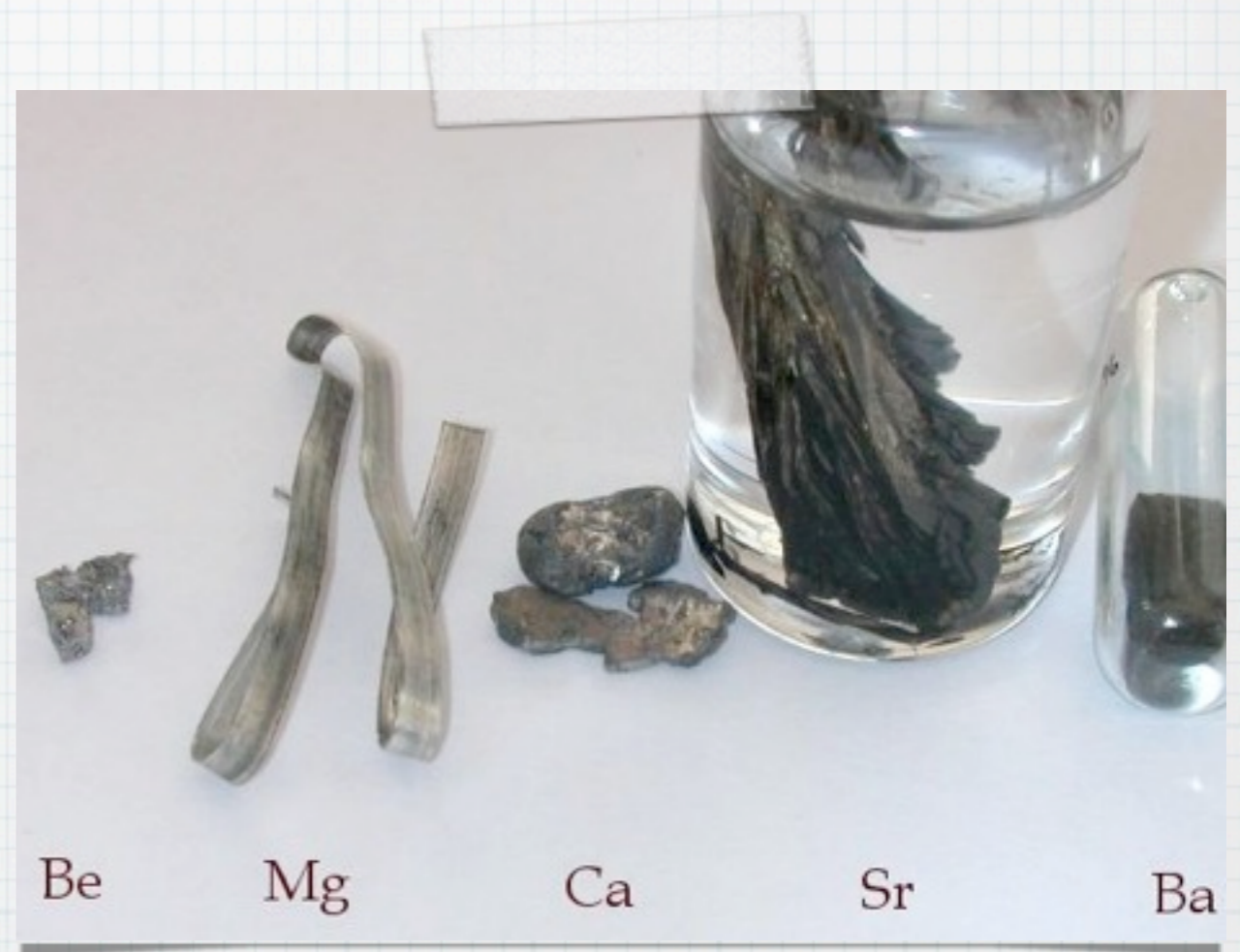
Group 2: The Alkaline Earth Metals

- * Elements: Be, Mg, Ca, Sr, Ba, Ra
- * Reactive
- * Shared Physical Properties:
 - * solids at rt.
 - * Metallic character



Group 2: The Alkaline Earth Metals

- * All alkaline earth elements have a valency of 2^+
- * Have two electrons in their outer shell.
- * Ready to lose those two electrons in ionic bonding with other elements.



Group 3-12: Transition Metals

- * Form complexes
- * Have variable valency



Main-group Elements

Transition Metals

Main-group Elements

H																				
Li	Be																		H	He
Na	Mg											B	C	N	O	F	Ne			
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Al	Si	P	S	Cl	Ar			
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	Ga	Ge	As	Se	Br	Kr			
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	In	Sn	Sb	Te	I	Xe			
Fr	Ra	Ac	Rf	Ha	106	107	108	109				Tl	Pb	Bi	Po	At	Rn			

Lanthanides

Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
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Actinides

Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr
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Inner Transition Elements

- * There are two series of inner transition elements.
- * Lanthanides
- * Actinides

Lanthinides

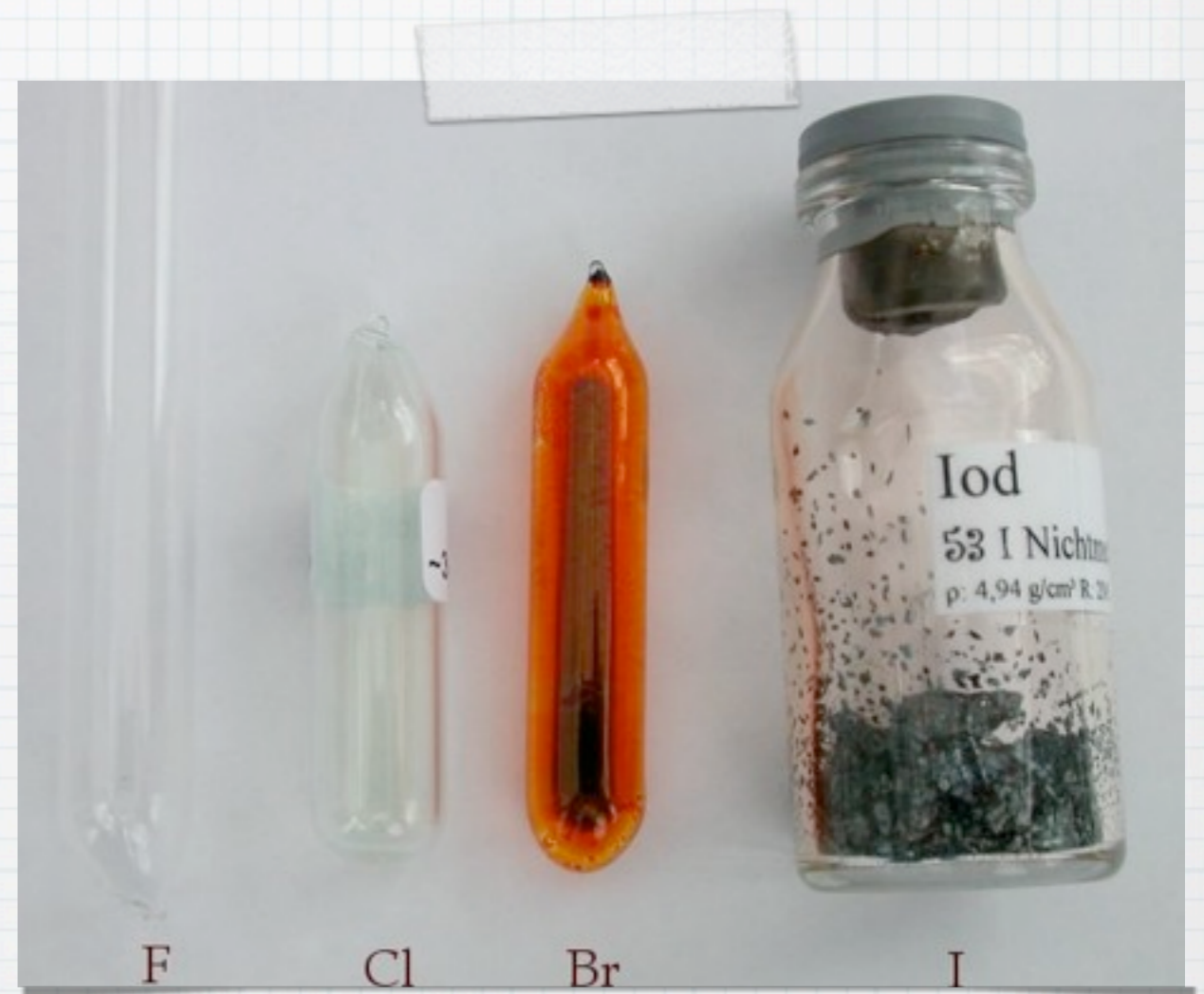
- * Soft metals that can be cut with a knife.
- * The elements are so similar that they are hard to separate when they occur in the same ore, which they often do.

Actinides

- * All the actinides are radioactive.
- * The nuclei of atoms of radioactive elements are unstable and decay to form other elements.

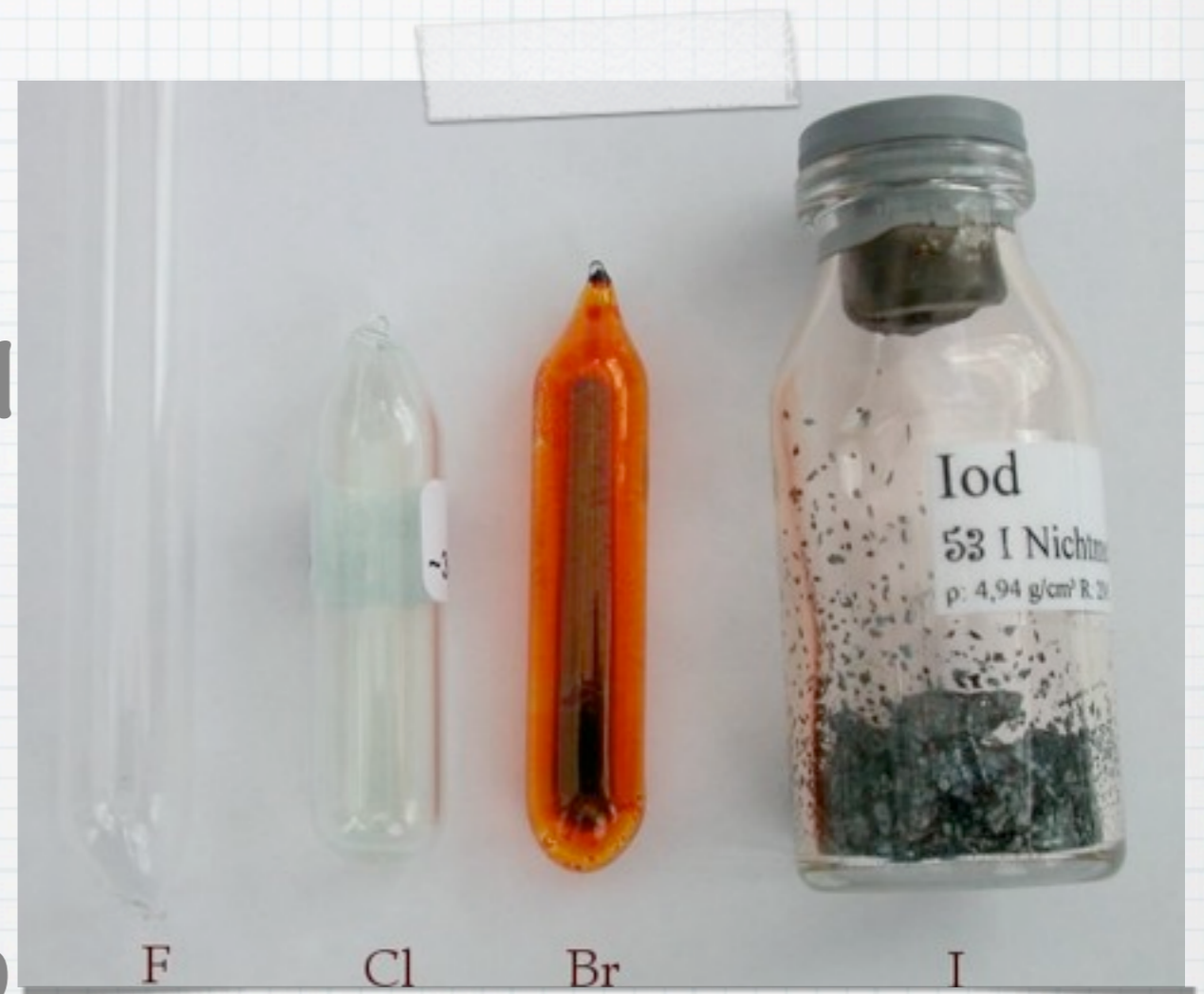
Group 17: The Halogens

- * Elements: F, Cl, Br, I, At
- * Reactive
- * Shared Physical Properties:
 - * Gas, liquid or solids at rt.
 - * Non-metallic



Group 17: The Halogens

- * Seven valence electrons, needs only one more have full shell
- * Valency of 1^-
- * Tend to gain one electron to form a halide, X^- ion, but also share electrons.



Group 18: The Noble Gases

- * Elements: He, Ne, Ar, Kr, Xe, Rn
- * Shared Physical Properties:
 - * Gases at rt.
 - * Non-metallic
- * Shared Chemical Properties:
 - * Very unreactive
 - * Stable monoatomic atoms

