THE PERIODIC TABLE

Now that we've seen how electrons are bound to atoms, that they occupy **orbitals** with strict rules about how many atoms occupy what kind of odd-looking region around the nucleus, we're in a position to understand the layout of the periodic table. That understanding will help us to use the table as a tool for solving all kinds of problems, and for remembering facts that are easy to forget - the table will make it easy.

First let's have a look at the periodic table. Click on the one below to print it. I'll discuss some of its features below using smaller diagrams and pulled-out sections, so you might want to refer to the full table often.

The first thing that probably strikes you about the table is its odd shape. You've seen it before, but you've probably never understood *why* it's laid out like it is. It's all about the **electron configurations**. Take a look at this table, in which each element has been replaced by its electron configuration, to understand:

Periodic Table of the Elements

1A	2A	3B	4B	5B	6B	7B	8B	8B	8B	1B	2B	3A	4A	5A	6A	7A	0
1 H 1.00797																	2 He 4.0026
3 Li 6.941	4 Be 9.0122											5 B 10.811	6 C 12.01115	7 N 14.0067	8 O 15.9994	9 F 18.9984	10 Ne 20.179
11 Na 22.9898	12 Mg 24.305											13 Al 26.9815	14 Si 28.086	15 P 30.9738	16 S 32.064	17 Cl 35.453	18 Ar 39.948
19 K 39.098	20 Ca 40.08	21 Sc 44.956	22 Ti 47.90	23 V 50.942	24 Cr 51.996	25 Mn 54.9380	26 Fe 55.847	27 Co 58.9332	28 Ni 58.70	29 Cu 63.54	30 Zn 65.38	31 Ga 69.72	32 Ge 72.59	33 As 74.9216	34 Se 78.96	35 Br 79.904	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.905	40 Zr 91.22	41 Nb 92.906	42 Mo 95.94	43 Tc (99)	44 Ru 101.07	45 Rh 102.905	46 Pd 106,4	47 Ag 107.868	48 Cd 112.41	49 In 114.82	50 Sn 118.69	51 Sb 121.75	52 Te 127.60	53 I 126.9045	54 Xe 131.30
55 Cs 132.905	56 Ba 137.53	57 La 138.91	72 Hf 178.49	73 Ta 180.948	74 W 183.85	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.09	79 Au 196.967	80 Hg 200.59	81 Tl 204.37	82 Pb 207.19	83 Bi 208.980	84 Po (210)	85 At (210)	86 Ra (222)
87 Fr (223)	88 Ra 226.0254	89 Ac (227)	104 Rf (257)	105 Ha (260)	106	107	108	109									

transuranium elements

Lanthanides	58 Ce 140.12	59 Pr 140.9077	60 Nd 144.24	61 Pm (147)	62 Sm 150.35	63 Eu 151.96	64 Gd 157.25	65 Tb 158.925	66 Dy 162.50	67 Ho 164.930	68 Er 167.26	69 Tm 168.934	70 Yb 173.04	71 Lu 174.97
Actinides	90 Th 232.038	91 Pa 231.0359	92 U 238.03	93 Np 237.0482	94 Pu (242)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (254)	100 Fm (254)	101 Md (258)	102 No (259)	103 Lr (260)

1A	2A	3B	4B	5B	6B	7B	8B	8B	8B	1B	2B	3A	4A	5A	6A	7A	0
$1s^1$	$1s^2$																
$2s^1$	$2s^2$											$2p^1$	$2p^2$	$2p^3$	$2p^4$	$2p^5$	$2p^6$
$3s^1$	$3s^2$											$3p^1$	$3p^2$	$3p^3$	$3p^4$	$3p^5$	$3p^6$
$4s^1$	$4s^2$	$3d^1$	$3d^2$	$3d^3$	$3d^4$	$3d^5$	$3d^6$	$3d^7$	$3d^8$	$3d^9$	$3d^{10}$	$4p^1$	$4p^2$	$4p^3$	$4p^4$	$4p^5$	$4p^6$
$5s^1$	$5s^2$	$4d^1$	$4d^2$	$4d^3$	$4d^4$	$4d^5$	$4d^6$	$4d^7$	$4d^8$	$4d^9$	$4d^{10}$	$5p^1$	$5p^2$	$5p^3$	$5p^4$	$5p^5$	$5p^6$
$6s^1$	$6s^2$	$5d^1$	$5d^2$	$5d^3$	$5d^4$	$5d^5$	$5d^6$	$5d^7$	$5d^8$	$5d^9$	$5d^{10}$	$6p^1$	$6p^2$	$6p^3$	$6p^4$	$6p^5$	$6p^6$
$7s^1$	$7s^2$	$6d^1$	$6d^2$	$6d^3$	$6d^4$	$6d^5$	$6d^6$	$6d^7$									

I've written He over here because it makes better sense for now.

transuranium elements

Lanthanides	$4f^1$ →	$4f^{14}$
Actinides	$4f^1$ →	$4f^{14}$

Look at the first (yellow) row in the table above. Hydrogen and Helium are elements 1 and 2, respectively, and have those numbers of electron (we always assume neutral atoms in the table). The electron configurations are H: $1s^1$ and He: $1s^2$. After that, the n=1 shell is full; it contains only an s-orbital and that can only hold two electrons. I've placed He over next to H in this table just to show that it lines up with all of the elements below it. We generally place it on the far right (like the first table) for another reason (I'll get to that later).

Now the blue row: Here the n=2 row is being filled. First the s-orbital is filled with two electrons (Li and Be), then across to the six p-

orbital electrons, ending with Neon, which has a full n=2 shell - no more electrons will fit into the n=2 shell. Notice that He, Ne and all of the atoms below Ne have full shells with increasing n. These atoms also happen to be the *least reactive* atoms in the table - food for thought.

Now the n=3 shell (pink): First the 3s orbital is filled with two electrons (Na, Mg), then we skip over to the 3p orbitals, filling them until we get to Argon (Ar). What happens next is perfectly in keeping with the **diagonal rule** that we learned in the last section. First the 4s orbital, because it is of lower energy than the 3d orbitals, is filled (K and Ca), *then* we fill the 3d orbitals in the next row down.

The periodic table is arranged in order of orbital filling, according to the diagonal rule. The first two columns fill s-orbitals. The rightmost six columns fill p-orbitals. The middle group of ten fills the d-orbitals, and the Lanthanide and Actinide series (block below the main table) fill the f-orbitals.

The periodic table is just another expression of the **diagonal rule** of electron-orbital filling, and can be used to write the electron configuration of any atom, just by reading left-to-right, top-to-bottom.

Now we can address the issue of the **relative stability** of atoms. It was already noted that elements in the rightmost column of the table are especially non-reactive. In fact, their electrons are tightly bound and difficult to remove. Note that all of these atoms have **eight** electrons in their outermost (highest n) shell.

Sources: http://www.drcruzan.com/Chemistry_PeriodicTable.html