The Structure of the Elements

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Abstract

The Natural Philosophy of Universal Matter ends with the creation of an atom of hydrogen. How then is the balance of elements created? This spreadsheet describes the building of elements by placing protons and neutrons in specified orders which includes all of the elements and their common isotopes. This document illustrates bits and parts of the sheet in order to allow an interested party to work through the structured build.

1 General Statements

Tabs In the build spreadsheet, named 'AtomicStructure.xlsx', Figure 1 shows the two tabs 'Itemized' (for build detail) and 'Graphic' (for a picture of the build detail) side-by-side. If possible, it is best to view the two sheets side-by-side, as illustrated in Figure 2.

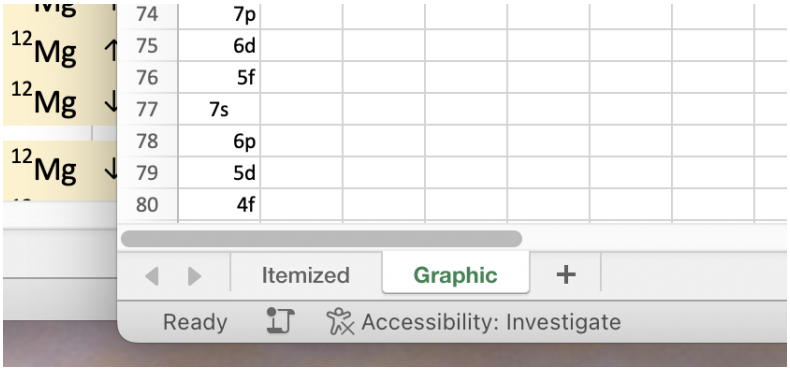


Figure 1: Showing Both Tabs

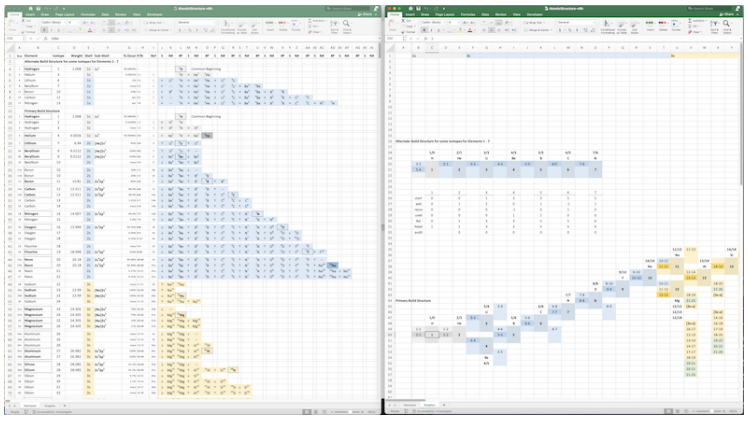
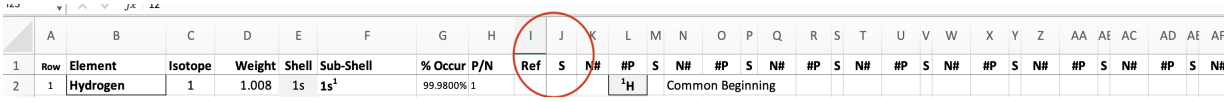


Figure 2: List and Graphic Side-By-Side

Frozen Panes Figure 3 shows the Itemized tab, columns A - I and row 1 as frozen panes:



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF
1	Row	Element	Isotope	Weight	Shell	Sub-Shell	% Occur	P/N	Ref	S	N#	#P	S	N#	#P	S	N#	#P	S	N#	#P	S	N#	#P	S	N#	#P	S	N#	#P	S	N#
2	1	Hydrogen	1	1.008	1s	$1s^1$	99.9800%	1				^{1}H		Common Beginning																		

Figure 3: Frozen Panes

1.1 Color Coding

1.1.1 Columns and Rows

Both the Itemized and Graphic tabs illustrate an atom's shells in a color-coded fashion. For example, in Figure 4, the Itemized tab on the left, and the Graphic tab on the right, show that the first shell contains two elements, hydrogen and helium. Rows for this shell and these elements are color-coded gray. The second shell, containing lithium to neon, is color-coded medium blue in each tab. The color-coding is used consistently even when crossing between shells.

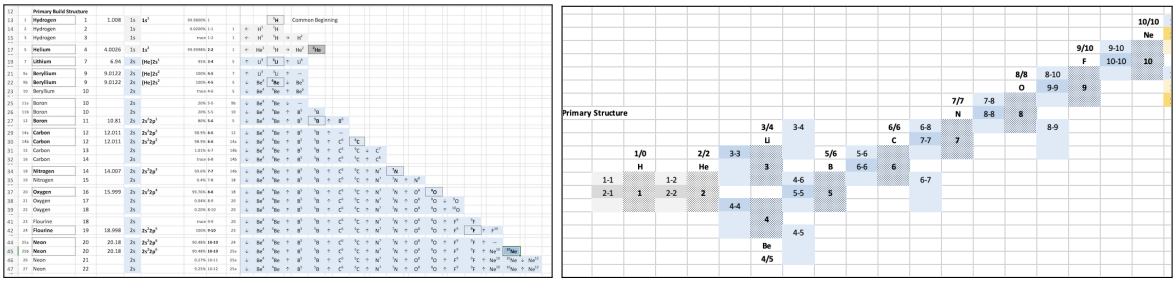
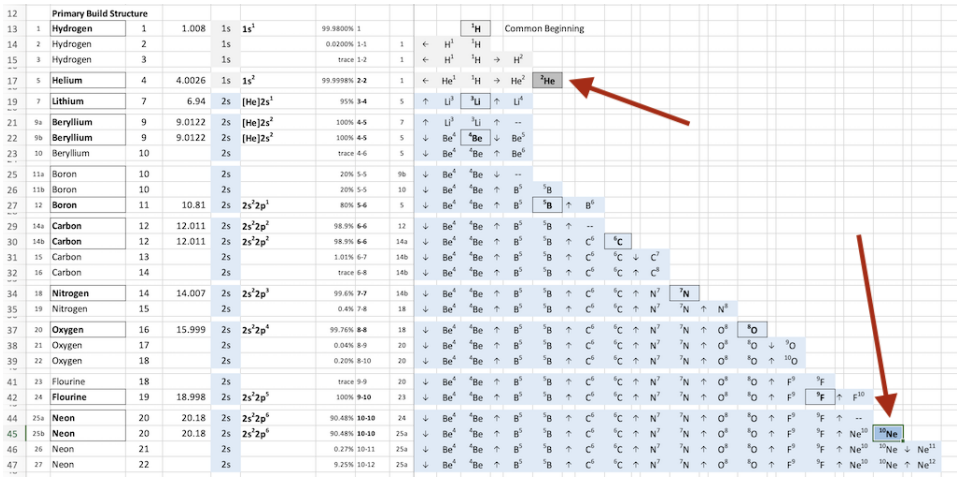


Figure 4: Color Coding

1.1.2 Final Elements in Shells

Each shell has a 'final' element, e.g., helium in shell one and neon in shell two. These final elements are denoted by an emphasized color, for example darker gray for helium and darker blue for neon. See the arrows in the following Figure 5.



		Primary Build Structure									
13	1	Hydrogen	1	1.008	1s	$1s^1$	99.9800%	1			^{1}H Common Beginning
14	2	Hydrogen	2		1s		0.0200%	1-1	1	←	H^1 ^{1}H
15	3	Hydrogen	3		1s		trace	1-2	1	←	H^1 ^{1}H → H^2
17	5	Helium	4	4.0026	1s	$1s^2$	99.9998%	2-2	1	←	He^1 ^{1}H → He^2 ^{2}He
19	7	Lithium	7	6.94	2s	$[He]2s^1$	95%	3-4	5	↑	Li^3 ^{3}Li ↑ Li^4
21	9a	Beryllium	9	9.0122	2s	$[He]2s^2$	100%	4-5	7	↑	Li^3 ^{3}Li ↑ --
22	9b	Beryllium	9	9.0122	2s	$[He]2s^2$	100%	4-5	5	↓	Be^4 ^{4}Be ↓ Be^5
23	10	Beryllium	10		2s		trace	4-6	5	↓	Be^4 ^{4}Be ↑ Be^6
25	11a	Boron	10		2s		20%	5-5	9b	↓	Be^4 ^{4}Be ↓ --
26	11b	Boron	10		2s		20%	5-5	10	↓	Be^4 ^{4}Be ↑ B^5 ^{5}B
27	12	Boron	11	10.81	2s	$2s^22p^1$	80%	5-6	5	↓	Be^4 ^{4}Be ↑ B^5 ^{5}B ↑ B^6
29	14a	Carbon	12	12.011	2s	$2s^22p^2$	98.9%	6-6	12	↓	Be^4 ^{4}Be ↑ B^5 ^{5}B ↑ --
30	14b	Carbon	12	12.011	2s	$2s^22p^2$	98.9%	6-6	14a	↓	Be^4 ^{4}Be ↑ B^5 ^{5}B ↑ C^6 ^{6}C
31	15	Carbon	13		2s		1.01%	6-7	14b	↓	Be^4 ^{4}Be ↑ B^5 ^{5}B ↑ C^6 ^{6}C ↓ C^7
32	16	Carbon	14		2s		trace	6-8	14b	↓	Be^4 ^{4}Be ↑ B^5 ^{5}B ↑ C^6 ^{6}C ↑ C^8
34	18	Nitrogen	14	14.007	2s	$2s^22p^3$	99.6%	7-7	14b	↓	Be^4 ^{4}Be ↑ B^5 ^{5}B ↑ C^6 ^{6}C ↑ N^7 ^{7}N
35	19	Nitrogen	15		2s		0.4%	7-8	18	↓	Be^4 ^{4}Be ↑ B^5 ^{5}B ↑ C^6 ^{6}C ↑ N^7 ↑ N^8
37	20	Oxygen	16	15.999	2s	$2s^22p^4$	99.76%	8-8	18	↓	Be^4 ^{4}Be ↑ B^5 ^{5}B ↑ C^6 ^{6}C ↑ N^7 ^{7}N ↑ O^8 ^{8}O
38	21	Oxygen	17		2s		0.04%	8-9	20	↓	Be^4 ^{4}Be ↑ B^5 ^{5}B ↑ C^6 ^{6}C ↑ N^7 ^{7}N ↑ O^8 ^{8}O ↓ ^{9}O
39	22	Oxygen	18		2s		0.20%	8-10	20	↓	Be^4 ^{4}Be ↑ B^5 ^{5}B ↑ C^6 ^{6}C ↑ N^7 ^{7}N ↑ O^8 ^{8}O ↑ ^{10}O
41	23	Flourine	18		2s		trace	9-9	20	↓	Be^4 ^{4}Be ↑ B^5 ^{5}B ↑ C^6 ^{6}C ↑ N^7 ^{7}N ↑ O^8 ^{8}O ↑ F^9 ^{9}F
42	24	Flourine	19	18.998	2s	$2s^22p^5$	100%	9-10	23	↓	Be^4 ^{4}Be ↑ B^5 ^{5}B ↑ C^6 ^{6}C ↑ N^7 ^{7}N ↑ O^8 ^{8}O ↑ F^9 ^{9}F ↑ F^{10}
44	25a	Neon	20	20.18	2s	$2s^22p^6$	90.48%	10-10	24	↓	Be^4 ^{4}Be ↑ B^5 ^{5}B ↑ C^6 ^{6}C ↑ N^7 ^{7}N ↑ O^8 ^{8}O ↑ F^9 ^{9}F ↑ --
45	25b	Neon	20	20.18	2s	$2s^22p^6$	90.48%	10-10	25a	↓	Be^4 ^{4}Be ↑ B^5 ^{5}B ↑ C^6 ^{6}C ↑ N^7 ^{7}N ↑ O^8 ^{8}O ↑ F^9 ^{9}F ↑ Ne^{10} ^{10}Ne
46	26	Neon	21		2s		0.27%	10-11	25a	↓	Be^4 ^{4}Be ↑ B^5 ^{5}B ↑ C^6 ^{6}C ↑ N^7 ^{7}N ↑ O^8 ^{8}O ↑ F^9 ^{9}F ↑ Ne^{10} ^{10}Ne ↓ Ne^{11}
47	27	Neon	22		2s		9.25%	10-12	25a	↓	Be^4 ^{4}Be ↑ B^5 ^{5}B ↑ C^6 ^{6}C ↑ N^7 ^{7}N ↑ O^8 ^{8}O ↑ F^9 ^{9}F ↑ Ne^{10} ^{10}Ne ↑ Ne^{12}

Figure 5: Final Shell Elements

2 Building Structures for Elements

2.1 Atom Rotation

The build structure, as noted on the Graphic tab, is written out left-to-right. But, keep in mind that the hydrogen proton rotates end-over-end and, as neutrons (first) and then protons are added to the 'chain', their additional rotations are added to the mix. The rotations of the triple-primes allow the 'chain' to rotate and loop back on itself, forming spiral layers as the atoms grow in complexity.

The rotational complexity, even when adding the first neutron to hydrogen, demonstrates the difficulty of 'growing the build'. Not only do neutrons and protons have to align to the neighboring triple-prime, but they must also match their rotational velocity. The needed pressure to do so must be strong and persistent and thus very few atoms are made without additional help[1]. These are hydrogen, helium, and traces of lithium and beryllium.

2.2 Primary (Common) and Alternate (Beginning) Structures

Figure 6 and Figure 7 detail two structures: One for a standard build, and one for an alternate build. The alternate structure is limited to just a few beginning elements (hydrogen through nitrogen) and some of their uncommon isotopes. The primary structure details the build for all the rest of the elements (and their isotopes). See arrows and text in the following figures:

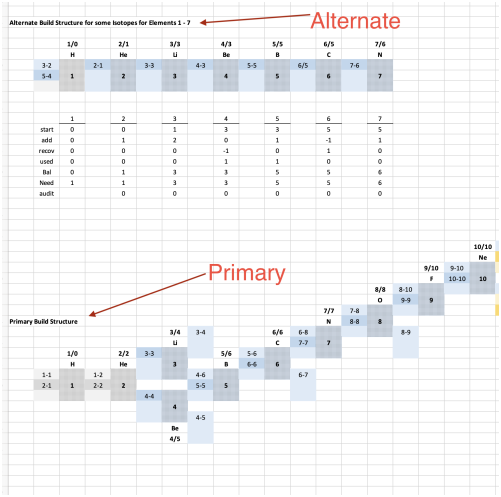


Figure 6: Graphic Build Structures

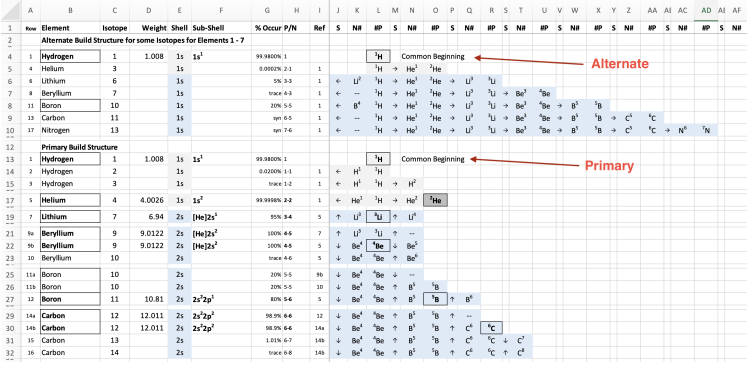


Figure 7: Itemized Element Structures

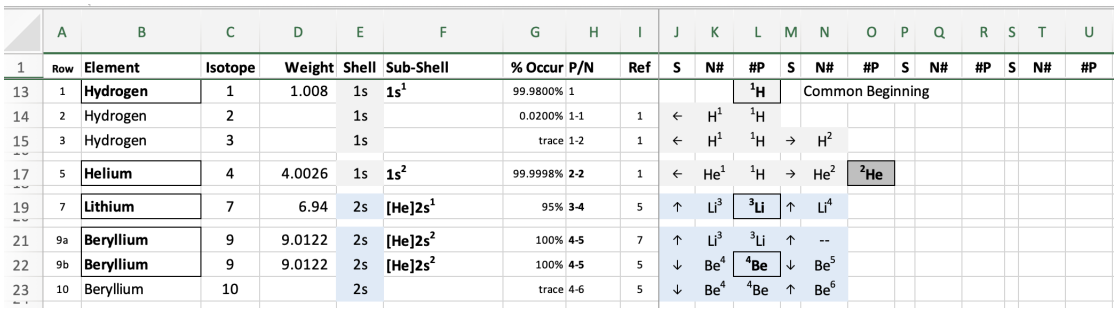
[1]Such as in stars, at the end of a star's lifetime, and in the lab.

2.3 Understanding the Itemized Tab

2.3.1 Shell Folding

Each color-coded shell is folded underneath the previous shell, as illustrated in Figure 8. Consider spreadsheet column 'A', with the header labeled 'Row', marked '5', which illustrates helium, the last element in the first shell. The first element of the second shell, lithium, might begin right next to helium, in spreadsheet column P, but this spreadsheet cell is blank. Now, move to header-row seven, lithium. Note that it 'starts' in spreadsheet column J, just like the first shell and not spreadsheet column P.

For readability purposes, after the final element of any shell, the first and subsequent elements the new shell are folded down (to spreadsheet column J) and given a new color (see color-coding).



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1	Row	Element	Isotope	Weight	Shell	Sub-Shell	% Occur	P/N	Ref	S	N#	#P	S	N#	#P	S	N#	#P	S	N#	#P
13	1	**Hydrogen**	1	1.008	1s	$1s^1$	99.9800%	1				^{1}H		Common Beginning							
14	2	Hydrogen	2		1s		0.0200%	1-1	1	←	H^1	^{1}H									
15	3	Hydrogen	3		1s		trace	1-2	1	←	H^1	^{1}H	→	H^2							
17	5	**Helium**	4	4.0026	1s	$1s^2$	99.9998%	2-2	1	←	He^1	^{1}H	→	He^2	^{2}He						
19	7	**Lithium**	7	6.94	2s	$[He]2s^1$	95%	3-4	5	↑	Li^3	^{3}Li	↑	Li^4							
21	9a	**Beryllium**	9	9.0122	2s	$[He]2s^2$	100%	4-5	7	↑	Li^3	^{3}Li	↑	--							
22	9b	**Beryllium**	9	9.0122	2s	$[He]2s^2$	100%	4-5	5	↓	Be^4	^{4}Be	↓	Be^5							
23	10	Beryllium	10		2s		trace	4-6	5	↓	Be^4	^{4}Be	↑	Be^6							

Figure 8: Itemized Column Header

2.3.2 Itemized Tab Columns

Let's detail the first group of columns, A-I, of the Itemized tab as shown in Figure 8:

- Row: Numbers each isotope. If the isotope needs additional rows, then a letter is added. For example, see Beryllium which needs two rows and so is marked 9a and 9b.
- Element: Name of element. Note: A box is placed around primary isotopes for ease of reading. Also, if the isotope has additional rows, then all of the rows are boxed together. For example, see the fourth element beryllium.
- Isotope: Similar to Row but uses a cardinal number only.
- Weight: Listed for primary isotopes only. For example, row one for hydrogen and row five for helium.
- Shell: Shell number (per common documentation, such as Wikipedia).
- Sub-shell: A more detailed labeling for the element in the shell. See example in **??**, in the box labeled 'A', for details of this type of notation.
- % Occur: Percent of occurrence in nature. Note: Synthetic elements are marked as 'syn' for a percentage.
- P/N: The count of protons and neutrons for the element.
- Ref: A number referencing the previous row from which the build detail (starting in the next column J) continues.

2.3.3 Itemized Build Columns

Figure 9 illustrates a second hearer grouping which consists of a series of three columns, repeated as necessary, to complete the entry. The repeated, three-column group is 'S', 'N#', and '#P' (e.g., spreadsheet columns J, K, and L).

- S: This is the build sub-item directional sign. From the last item or sub-item, add the neutron or proton in the indicated direction. Valid directions are up, down, right, and left.

- N#: Element abbreviation with neutron number in superscript.
- #P: Proton number in superscript with element abbreviation.

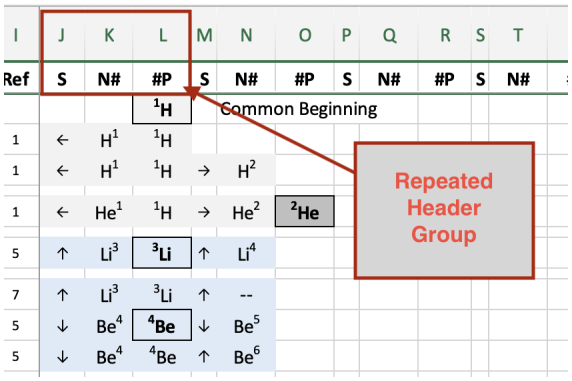


Figure 9: Itemized Build: Column Header

2.4 Understanding the Graphic Tab

2.4.1 Graphic Chart Color-Coding

Illustrated n Figure 10, color-coding is used to aid reading the Graphic build chart. Items of interest are as follows:

- A: Proton marking. It is the darker base color with small-dot fill.
- B: Neutron marking. Here indicating that it was used to designate the second neutron for element one, hydrogen. It is marked by a lighter variant of the element's shell base color.
- C: Neutron marking. The darker base color marking indicates that it was the final instance of a neutron used in conjunction with a proton and will be used in this place throughout the rest of the chart. In the example, it denotes that it was the second neutron used in conjunction with the second element, helium.
- D: A minimum of two indicators are listed above each proton. In this example, the first indicator is the fifth element, boron, so marked with the abbreviation 'B', for the element in the cell above the proton marking. The second indicator is in the cell above and the abbreviation is the proton/neutron combination for a boxed, primary isotope for the element (see sub-section 2.3.2, the element column).

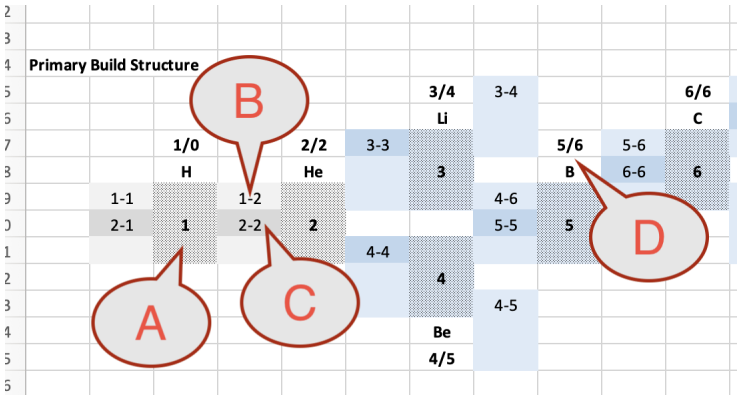


Figure 10: Graphic Color-Coding

Please note the comments for item D in the list above: In some cases there may be several listed proton/neutron combinations, listed in reverse ascending order (as illustrated in Figure 11). The reason for this is that an element may have more than one primary isotope, such as chlorine. This element, number 17 on the Periodic Table, has two natural occurring isotopes, each one having at lease 10% prevalence in nature (see Item row numbers 49a/b and 51 on the Itemized tab).

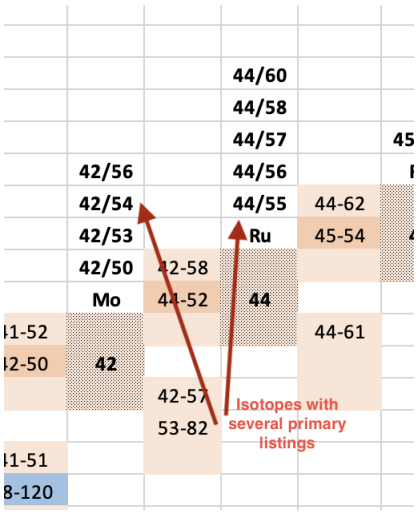


Figure 11: Graphic Showing Primary Isotopes

Please see Figure 10, in sub-section 2.4.1, and note the comments for items 'B' and 'C' for neutron markings. In some cases the neutron list contained more than three neutrons. In these instances, a cross referenced list was created above or below the element in question as illustrated. For example, consider the following figure detailing the neutron to the lower-right side of element 12, magnesium.

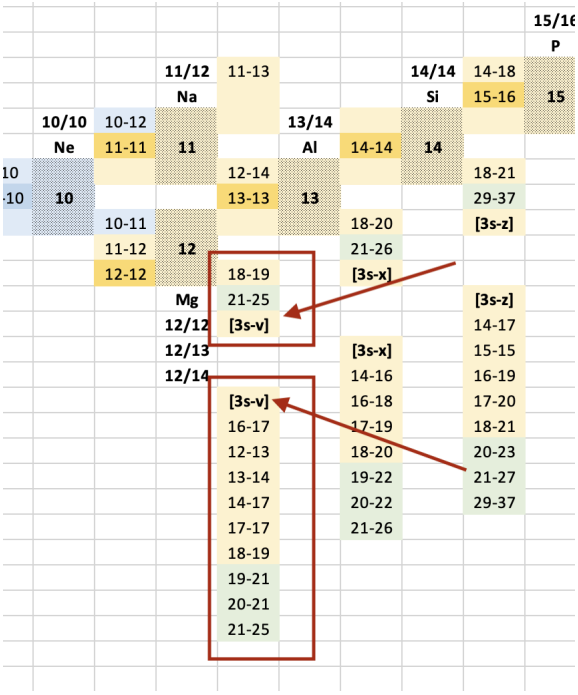


Figure 12: Extended Neutron Lists

In this figure, note the smaller rectangle with the longer rectangle below it. In the smaller box, the highest cell contains '18-19' which is the last neutron used to complete the third (yellow) shell. Below this cell, the middle cell '21-25' refers to the next-to-last neutron used in this place in the fourth (green) shell. Finally, in the smaller box, in the bottom cell, '[3s-v]' refers to the extended list shown in the longer rectangle box directly below the smaller box.

Note that '[3s-v]', serving as a reference, shows at the top of the longer box and begins the extended list. The reference link is bracketed followed by the shell number and sub-shell letter, in this case '3s'. Next, after the dash, the Excel column letter (or letters) indicate where to find the list. It is usually below if the neutron is low on the chart or above if otherwise.

3 Examples

Building examples will help solidify the above documentation. In these exercises we will build hydrogen and helium, and then lithium through boron.

3.1 Hydrogen and Helium

Building helium from hydrogen will help you to understand the build nomenclature of the Itemized tab and apply it to the Graphic tab. To aid this discussion, let's view the Itemized and Graphic tabs together:

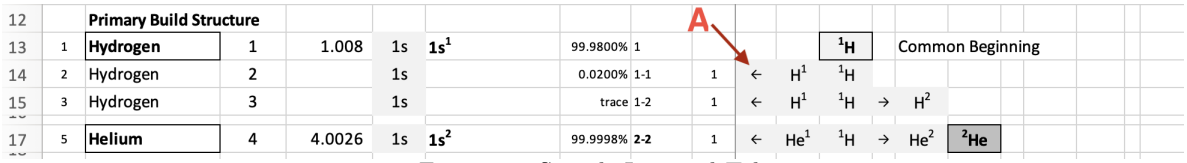


Figure 13: Sample Itemized Tab

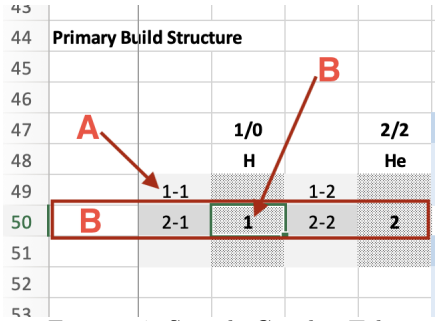


Figure 14: Sample Graphic Tab

In Figure 13, on the Itemized tab, note common beginning for hydrogen in spreadsheet row 13, with the box ^1H, located in the proton column 'L'. Let's add two isotopes for hydrogen, one with one neutron added to the proton (spreadsheet row 14) and one adding two neutrons to the one proton (on spreadsheet row 15).

At spreadsheet row 14, in the cell directly below the boxed hydrogen cell, the build directions (at 'A') tells us to add the neutron. labeled H^1, to the proton. So we need to place a neutron, numbered '1', on the Graphic build chart.

The text-arrow 'A' points to cell with a left pointing arrow. This means that we will place the neutron to the left of the proton. Now let's shift our attention to Figure 14.

On the Graphic tab, we'll move one column to the left of the proton column labeled '1' in the middle of the darker gray area (see the text-arrow labeled 'B') and place a '1-1' in the top cell of the three available cells in the neutron column (pointed out by text-arrow 'A'). Label the neutron with the element number '1', followed by a dash, and then the neutron number '1'. This completes the hydrogen isotope '1-1', completing spreadsheet row 14. Now let's move to spreadsheet row 15 on the Itemized tab.

Note that the build instructions in spreadsheet row 14 are repeated in spreadsheet row 15 but note that we will not have to repeat these instructions for the next build item, that is placing a second neutron next to the proton.

Start with the cell directly to the right of the cell labeled ^{1}H. To the right of this cell note the cell with a black, right pointing arrow and, to the right of it, H^{2}. This means we are to place a second neutron to the right of the proton column on the Graphic tab and label it '1-2', meaning it is the second neutron for element number '1', hydrogen. This completes the build for second hydrogen isotope, '1-2'. Now we can easily create the helium atom.

On the Itemized tab note spreadsheet row 17, the row that has the instructions to builds helium. This build requires only a single instruction row but you will note that the neutrons for the first and second hydrogen isotopes have been relabeled as neutrons for helium. This is due to the fact that these neutron designations will remain as such for the balance of the build chart.

Now we will add a (second) proton needed for helium. On the Itemized tab, in spreadsheet row 17, note that the next proton is to be placed next to the second neutron and labeled ^{2}He. On the Graphic tab, this is noted as a '2' in the middle of the darker three-cell (spreadsheet row 50). We also place a bold text item '2-2' (in spreadsheet row 47) and 'He' in the cell below (spreadsheet row 48). This completes the build chart for helium, and completes the first atomic shell[2].

3.2 Lithium, Beryllium, and Boron

Now that we have completed the first shell containing hydrogen and helium, let's build the first three elements of the second shell. As you will see, the beginning of a shell is always a busy place! We will need refreshed illustrations for both tabs.

17	5	**Helium**	4	4.0026	1s	**$1s^2$**	99.9998%	**2-2**	1	←	He^1	^1H	→	He^2	**^2He**			
19	7	**Lithium**	7	6.94	2s	**[He]$2s^1$**	95%	**3-4**	5	↑	Li^3	**^3Li**	↑	Li^4				
21	9a	**Beryllium**	9	9.0122	2s	**[He]$2s^2$** A	100%	**4-5**	7	↑	Li^3	^3Li	↑	--				
22	9b	**Beryllium**	9	9.0122	2s	**[He]$2s^2$**	100%	**4-5**	5	↓	Be^4	**^4Be**	↓	Be^5				
23	10	Beryllium	10		2s		trace	4-6	5	↓	Be^4	^4Be	↑	Be^6				
25	11a	Boron	10		2s		20%	5-5	9b	↓	Be^4	^4Be	↓	--				
26	11b	Boron	10		2s		20%	5-5	10	↓	Be^4	^4Be	↑	B^5	^5B			
27	12	**Boron**	11	10.81	2s	**$2s^2 2p^1$**	80%	**5-6**	5	↓	Be^4	^4Be	↑	B^5	**^5B**	↑	B^6	

Figure 15: Second Shell: Itemized Tab

Note that in Figure 15, the Itemized tab shows the new new shell is folded underneath the last shell. But, on the Graphic tab, Figure 16, this is not the case: Here the new shell continues on from the last. To aide this fact on the Itemized tab, as noted in the text-box labeled 'A', the first two element entries of the new shell contain a bracketed entry for the final element of the previous shell, in this case helium.

The label [$He2s^1$] (on spreadsheet rows 19), for lithium, means it continues directly from helium and constitutes the first proton on sub-shell 's' in shell '2'[3]. So we see in Figure 16, the Graphic tab, that lithium goes 'up' from helium. Lithium, going up from helium, constitutes the only element in sub-shell '1' of shell '2'.

[2]The special coloring for this cell is addressed discussions around Figure 5
[3]This is common nomenclature.

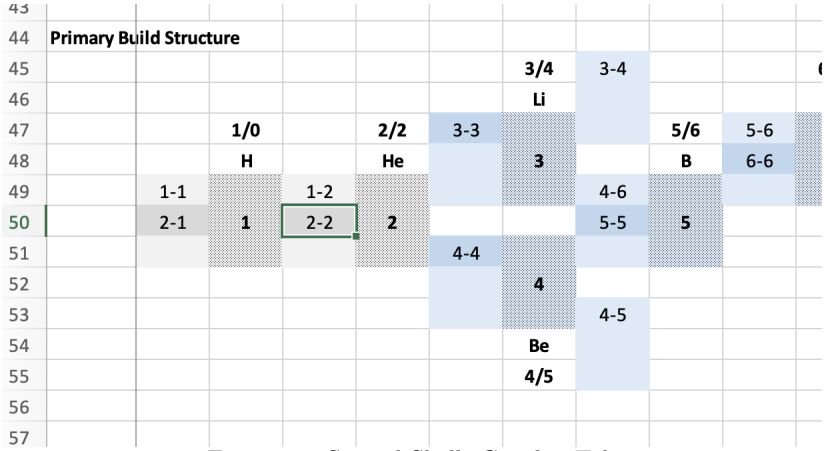


Figure 16: Second Shell: Graphic Tab

Also, in Figure 15 text-box 'A', is the label [He2s^2] (on spreadsheet rows 21 and 22). This means that beryllium is the second proton in shell '2', sub-shell '2' and, on the Graphic tab, proceeds 'down' from helium.

Let's observe some neutron nomenclature for lithium and beryllium on the Itemized tab. Here, on spreadsheet row 19, we note that lithium contains three protons and four neutrons. In addition, on rows 21 and 22, beryllium contains four protons and five neutrons. This can be correlated on the Graphic tab by neutrons '3-3' and '3-4' for lithium and neutrons '4-4' and '4-5' for beryllium. Note that neutron '3-4' is offset from proton '3' over one and up two cells. Neutron '4-5' is offset from proton '4' over one cell and two cells down. This offset is not structural and in nature the neutrons are not offset, rather they go directly next to their protons as in hydrogen and helium. But for visual purposes in building the chart, I have employed the offset for visual convenience.

Also note the difference in font for neutrons '3-3' and '3-4', and neutrons '4-4' and '4-5'. Neutrons '3-3' and '4-4' are in bold text but '3-4' and '4-5' are not. The bold font indicates that these neutrons are set in their positions and continue as such throughout the build. Neutrons '3-4' and '4-5' are not so and 'disappear' with the neutron positions remaining unused for additional elements. The fact that these neutron positions are left empty is noted on the Itemized tab in row '9a' for beryllium and '11a' for boron. In the build instructions for these two elements you'll note the '–' double-dash entries. These entries 'delete' the underlying neutrons and further build instructions for element do not replace them.

Beryllium isotope '4-6' adds a sixth neutron labeled '4-6' such that it straddles protons '3' for lithium and '4' for beryllium. Here we see the two outer ineffective primes of neutron '4-6' attach to the two outer effective primes of the two protons of lithium and beryllium. To build the next element, boron, we rename this sixth neutron for beryllium as neutron '5-5' as noted in row '11b'. The fifth added proton, that for boron, then attaches to this neutron.

3.3 A H^2O (Water) Molecule

A H_2O molecule (water) is made by adding two hydrogen atoms to oxygen. This is accomplished by adding a hydrogen atom to the top of lithium's neutron '3-3' and to the bottom of beryllium's neutron '4-4'. These are noted by the text-arrows in Figure 17. Note the join points (circled) showing hydrogen attaching to the outer ineffective primes for neutrons '3-3' and '4-4'.

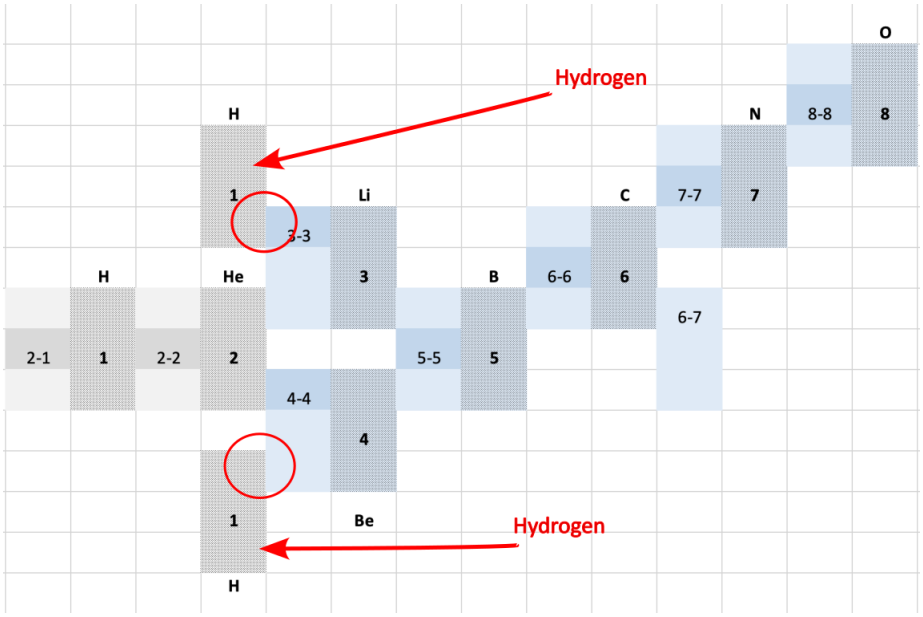


Figure 17: H_2O Molecule (Water)