CHEMICAL SYMBOLS OF ELEMENTS 110 AND BEYOND

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Introduction

In the February 2002 issue of Word Ways my article "The Symbols of the Chemical Elements" examined the symbols for the chemical elements with atomic numbers 1 to 109. Viewing the symbols as a sequence of 210 letters, I presented words that occurred "naturally" in that sequence (CLARK and CONIC were five-letter examples), words that could be made by transposition of the letters in adjacent symbols (e.g. SPORTIER can be formed from the symbols Re Os Ir Pt with atomic numbers 75-78), and words that can be made by transposition of symbols and part-symbols (e.g. CATARRH can be formed from the symbols (F)r Ra Ac Th with atomic numbers 87-90). At the end of that article I promised an exploration of the symbols for the theoretical chemical elements with atomic numbers from 110 onwards.

Elements 110-999

The basis for the remainder of this article is Dmitri Borgmann's article "New Elemental Vistas" in the February 1987 issue of Word Ways (a Dmitri Borgmann memorial issue). In that article, Dmitri described a systematic naming convention for the chemical elements with atomic numbers greater than 100. The convention, described below, was approved by a commission on the nomenclature of inorganic chemistry within the International Union of Pure and Applied Chemistry (IUPAC) in 1978. Dmitri's article describes the naming convention succinctly:

> "The new nomenclature rules…convert the atomic numbers of elements into verbal names by replacing each digit of the atomic number with a literal particle, as follows:
>
> | | | | |
> |---|---|---|---|
> | 0 = nil | 3 = tri | 6 = hex | 9 = enn |
> | 1 = un | 4 = quad | 7 = sept | |
> | 2 = bi | 5 = pent | 8 = oct | |
>
> These particles are combined to represent the element's atomic number, and followed by the termination –IUM to complete the element's systematic name. If the final I of BI or TRI occurs immediately before –IUM, it is omitted. If the final N of ENN occurs immediately before NIL, it is likewise dropped."

Dmitri gave 35 examples of the names generated for atomic numbers 101 to 900. Here are a few:

104 unnilquadium	120 unbinilium	200 binilnilium
105 unnilpentium	130 untrinilium	300 trinilnilium
106 unnilhexium	140 unquadnilium	400 quadnilnilium
107 unnilseptium	150 unpentnilium	500 pentnilnilium
108 unniloctium	160 unhexnilium	900 ennilnilium
109 unnilennium	170 unseptnilium	
110 ununnilium	180 unoctnilium	

It is now quite straightforward to generate the name for any of the (theoretical) elements. For example, the element with atomic number 123 would be UNBITRIUM; the element with atomic number 444 would be QUADQUADQUADIUM; the element with atomic number 690 would be HEXENNILIUM; and the element with atomic number 999 would be ENNENNENNIUM.

Indeed the systematic names and symbols for chemical elements 104-109 were used in my earlier article, with the authority of several dictionaries: Merriam-Webster's Collegiate Dictionary (10th edition, 1998 printing), The Concise Oxford Dictionary (9th edition, 1995), and The Chambers Dictionary (1998 edition). In that article, the symbols for these theoretical elements are simply composed of the correct combination of the initial letters of the ten particles. Thus, 104 unnilquadium is Unq, 105 unnilpentium is Unp, 106 unnilhexium is Unh, 107 unnilseptium is Uns, 108 unniloctium is Uno, and 109 unnilennium is Une. It can be seem that any symbol is created from the initial letters of the ten particles: N for 0, U for 1, B for 2, T for 3, Q for 4, P for 5, H for 6, S for 7, O for 8, and E for 9.

As there are ten different initial letters for the particles, there will be a precise one-to-one match between a given atomic number and its symbol. No symbol will be used for more than one atomic number, and no atomic number can generate more than one symbol. It also seems obvious that no atomic number can begin with the letter N, as this merely represents the equivalent of a leading zero. Element 675 would be just that, 675 (Hsp), and not 0675 (Nhsp).

Given that we now have a method of generating names and symbols for the chemical elements 110 and upwards, let's examine them in more detail and see what items of logological interest can be discovered. If the symbols for elements 110-999 are written down in sequence, that's a total of 890 symbols, and (with three letters per symbol) that's 2670 letters.

Question 1 *Using the 2670-letter sequence, what real words (four-letter and longer) are spelled out in order by adjacent letters of the symbols?*

Of course, we can only consider words using the letters NUBTQPHSOE. Not surprisingly, there is a whole slew of four-letter words. Any word beginning and ending with the same letter will provide an answer (in part) to this question. Here are 16 words, presented in increasing order of atomic number:

Boob Boo-B(oe) 288-289
Tout Tou-T(ob) 281-382
Tost Tos-T(oo) 387-388
Toot Too-T(oe) 388-389
Tent Ten-T(eu) 390-391
Test Tes-T(eo) 397-398
Poop Poo-P(oe) 588-589
Hunh Hun-H(uu) 610-611
Hush Hus-H(uo) 617-618
Heth Het-H(eq) 693-694
Onto Ont-O(nq) 803-804
Otto Ott-O(tq) 833-834
Oppo Opp-O(ph) 855-856
Epee Epe-E(hn) 959-960
Esne Esn-E(su) 970-971
Esse Ess-E(so) 977-978

This list can be extended by adding words beginning and ending with S, except for SEES (as the symbol See, atomic number 799, is followed by Onn, atomic number 800). Here are 15 more:

Suns Sun-S(uu) 710-711
Subs Sub-S(ut) 712-713
Suqs Suq- S(up) 714-715
Sues Sue-S(bn) 719-720
Shes She-S(sn) 769-770
Sobs Sob-S(ot) 782-783
Sots Sot-S(oq) 783-784
Sops Sop-S(oh) 785-786
Sohs Soh-S(os) 786-787
Sens Sen-S(eu) 790-791

Sons Son-S(ou) 780-781
Sous Sou-S(ob) 781-782
Sets Set-S(eq) 793-794

Another 16 words can be added by noting that any word beginning with H and ending with S is also valid:

Hubs (Ub)h-Ubs 126-127
Huts (Ut)h-Uts 136-137
Hups (Up)h-Ups 156-157
Huss (Us)h-Uss 176-177
Hues (Ue)h-Ues 196=197
Hons (On)h-Ons 806-807
Hobs (Ob)h-Obs 826-827
Hots (Ot)h-Ots 836-837
Hops (Op)h-Ops 856-857
Hohs (Oh)h-Ohs 866-867
Hoss (Os)h-Oss 876-877
Hoes (Oe)h-Oes 896-897
Hens (En)h-Ens 906-907
Hets (Et)h-Ets 936-937
Heps (Ep)h-Eps 956-957
Hehs (Eh)h-Ehs 966-967

I have omitted the word HUNS, generated by (Un)h-Uns, as this corresponds to atomic numbers 106-107, outside of the range of this article, and presented in my earlier article.

Further four-letter examples can be added, but these have to be generated by inspection, seeking likely combinations of adjacent symbols. Here are 4 examples:

Bust (Us)b-Ust 172-173
Push (Us)p-Ush 175-176
Bent (En)b-Ent 902-903
Best (Es)b-Est 972-973

That's a total of 51 four-letter examples. There are probably many others that can be found by further careful inspection.

Are there any five-letter examples? I have only been able to discover three such words:

Thoth Tho-Th(e) 368-369
Shush Shu-Sh(b) 761-762
Sense Sen-Se(u) 790-791

A fourth word, UNSUN (from Uns-Un(o) 107-108 appeared in my earlier article.

At the six-letter level, I have only been able to find three examples, one marred by a hyphen:

Bon-ton (On)b-Ont-On(q) 802-804
Benten (En)b-Ent-En(q) 902-904
Bestes (Es)b-Est-Es(q) 972-0\974

BON-TON is hyphenated in the Oxford English Dictionary, but spelled as two words, BON TON, in Webster's Third. BENTEN is from Webster's Second. BESTES is the plural of *beste*, an obsolete form of *beast* and *best* in both the OED and Webster's Second.

Question 2 *Using the 2670-letter sequence, what sets of adjacent symbols can be transposed to create real words?*

Within this question, I am looking to use all the letters of the symbols used rather than just one or two of the three letters. As an example, the word STUNTS can be generated from the two symbols Tsn and Tsu (atomic numbers 370-371), as well as the symbols Stn and Stu (atomic numbers 730-731). There doesn't seem to be any systematic way of generating such words—

careful inspection is required. Here are 19 examples, all six letters long, in atomic number order (any more?):

Pushup Uph-Ups 156-157
Bennet Bee-Tnn 299-300
Tenths The-Tsn 369-370
Stunts Tsn-Tsu 370-371
Teston Tse-Ton 379-380
Pushup Puh-Pus 516-517
Epopee Peo-Pee 598-599
Stunts Stn-Stu 730-731
Boosts Sob-Sot 782-783
Ensues Sen-Seu 790-791
Besets Seb-Set 792-793
Phonon Onp-Onh 805-806
Boosts Osb-Ost 872-873
Bootee Oeb-Oet 892-893
Bennet Enb-Ent 902-903
Epopee Epo-Epe 958-959
Ensues Esn-Esu 970-971
Besets Esb-Est 972-973
Bootee Eob-Eot 982-983

Notice how BENNET can be generated from two very different (and distant!) pairs of symbols, those for atomic numbers 299-300 and 902-903.

What about longer specimens? I haven't been able to find any genuine nine-letter examples, but there are some near misses. Here are 5 of those:

Nonsenses Sno-Sne-Sne 708-709-709
Sebestens Sen-Seb-Set 790-792-793
Sebestens Esn-Esb-Est 970-972-973
Septettes Tep-Tes-Tes 395-397-397
Septettes Etp-Ets-Ets 935-937-937

I had hoped to be able to find the word HEPTETTES, a possible variant of SEPTETTES. If HEPTETTES existed, that would provide us with

Heptettes Tep-The-Tes 395-396-397
Heptettes Etp-Eth-Ets 935-936-937

For example, both HEPTANGULAR and SEPTANGULAR exist with the same meaning. So do HEPTANE and SEPTANE, and HEPTAVALENT and SEPTAVALENT.

Question 3 *What transposals can be found for the new systematic names?*

At the end of his 1987 article, Dmitri commented "The first task, as I see it, is to find perfect transposals of each (new, systematic) name. I have started the ball rolling by transposing NEUTON into both UNTONE and NUTONE. The ball is now in your hands."

Bearing in mind that NEUTON, a once suggested name for the element with atomic number zero, is outside of the new naming system, I don't see this as much of a contribution. I suspect Dmitri's comment about finding transposals was a throwaway remark, made in the belief that the new systematic names were long, full of repeated letters, and therefore unlikely to be transposable. What Dmitri failed to realise was that many of the new element names were mutual transposals of each other. For example, here is a six-way transposal:

Quadpenthexium (456)	Pentquadhexium (546)	Hexquadpentium (645)
Quadhexpentium (465)	Penthexquadium (564)	Hexpentquadium (654)

However, it's not as simple as inferring that each element name has six mutual transpositions. Consider the case of element 114, called UNUNQUADIUM. This can be transposed to UNQUADUNIUM (element 141) and QUADUNUNIUM (element 411). Because of the repeated

UN particles, the number of transposals halves to just three transposals. In general, if there is a particle repeated, there can only be a maximum of three transposals. Even so, further care still needs to be taken with various element names:

- Those involving the BI and TRI particles, since the trailing I is dropped before –IUM
- Those involving the ENN and NIL particles, since ENNNIL is reduced to ENNIL
- Those involving the NIL particle, since element names cannot begin with NIL

Question 4 *For which elements in the atomic number range 110-999 are there* no *mutual transposals?*

First off, none of the atomic numbers 200, 300, 400, 500, 600, 700, 800 and 900 is transposable, because of the non-allowability of leading zeroes.

Secondly, atomic numbers 111, 222, 333, 444, 555, 666, 777, 888 and 999 are not transposable—at least not to names of other chemical elements

Thirdly, atomic numbers 112, 113, 442, 443, 552, 553, 662, 663, 772, 773, 882, 883, 992, and 993 (the first two particles repeated and the third particle BI or TRI) are not transposable—at least not to names of other chemical elements. However, elements with atomic numbers 223 and 332 are transposable, since the dropped-I issue applies equally to BI and TRI, allowing them to be interchanged.

Fourthly, elements with atomic numbers 220-229 and 330-339 are not transposable, with the exception of 223 and 332 as already noted—at least not to the names of other chemical elements.

Fifthly, elements with atomic numbers 202, 303, 402, 403, 502, 503, 602, 603, 702, 703, 802, 803, 902 and 903 are not transposable, with the exceptions of 302 and 203.

Sixthly, watch out for the ENN-NIL combination becoming ENNIL. Any valid transposals involving ENNIL needs to keep this sequence of letters intact. Element 190 can be transposed to element 901, as can the pairs 490-904, 590-905, 690-9096, 790-907, 890-908 and 990-909, but 290 and 902 are not mutually transposable, nor are 390 and 903, because of the BI/TRI problem.

By my reckoning, that means that at least 67 of the 890 element names in the atomic number range are not transposable, leaving (up to) 823 which are transposable! Perhaps I've overlooked some rules about non-transposability. Any readers care to identify further examples?

Question 5 *Can ordinary transposals be found for the new systematic names—i.e not transposing to systematic names of other elements in the 110-999 atomic number range? If not, what about near misses—such as transdeletions, especially single-letter ones?*

Though this article is concerned with elements 110-999, I couldn't help but notice that UNNILPENTIUM (element 105) and UNNILSEPTIUM (element 107) can both be transdeleted (by removal of three letters) to NEPTUNIUM (element 93), an element whose name isn't part of the new systematic convention.

Consider the name NEPTUNIUM carefully. Its letters can be broken into the parts UN, PENT and IUM. So, any element names using these three parts can be transdeleted to NEPTUNIUM! By my reckoning, that's 54 element names; we've already seen that element 105, UNNILPENTIUM, qualifies. Further, because the particle SEPT is only an N short of PENT, it's

apparent that any element name using the parts UN and IUM and any of NIL/UN/PENT/ENN (to provide the missing N) can also be transdeleted to NEPTUNIUM. That's another 19 element names with atomic numbers 117, 171, 711, 107, 170, 701, 710, 157, 175, 517, 571, 715, 751, 179, 197, 719, 791, 917 and 971—we've already seen that UNNILSEPTIUM qualifies. Taking care not to double-count certain names (e.g. 517), this is a total of 67 names. So, we can unhesitatingly claim that the names of 67 elements in the atomic number range 100-999 can be transdeleted to NEPTUNIUM, or 65 if we only consider the range 110-999, thereby excluding elements 105 and 107.

How about single-letter transdeletions?

- MULTIUNION is a single letter short of the parts NIL, UN, OCT and IUM. So elements 108, 180, 801 and 810 can all be single-letter transdeleted to MULTIUNION.
- CONTINUUM is a single letter short of the parts UN, UN, OCT and IUM. So elements 118, 181 and 811 can all be single-letter transdeleted to CONTINUUM.
- COMPUTERIST is a single letter short of the parts SEPT, OCT, TR (without the I) and IUM. So elements 783 and 873 can both be single-letter transdeleted to COMPUTERIST.
- INCOMPETENTS is a single letter short of the parts SEPT, OCT, ENN and IUM. So elements 789, 798, 879, 897, 978 and 987 can all be single-letter transdeleted to INCOMPETENTS.

I believe these four words are the only single-letter transdeletions of all the element names in the atomic number range 110-999. Anyone care to prove me wrong?

Beyond Element 999

So far in this article, I have concentrated on elements with atomic numbers in the range 110-999. As Dmitri Borgmann pointed out in his 1987 article:

> "In this scheme of things element 999 acquires the systematic name ENNENNENNIUM. It seems inconceivable to come so close to the magic number 1000 and stop just short of it. I propose the name MILLENIUM (sic! It should have two N's) for element 1000—the millennium (sic) will surely be at hand when scientists succeed in producing element 1000 in the laboratory."

Let's suppose that we can go beyond, wildly beyond, element 999. Assuming that the IUPAC naming convention for elements up to 999 could be extended upwards, i.e. from 1000, what interesting discoveries await us? Dmitri's suggestion of MILLENIUM (or even MILLENNIUM) for element 1000 clearly won't wash. The new systematic name is simply composed of the particles UN, NIL, NIL, NIL and the IUM ending—thus UNNILNILNILIUM, with the symbol Unnn.

Question 6 *In the atomic number range 1000-9999, how many elements have symbols which are legitimate four-letter words?*

Quite simply, this is a question of finding the four-letter words spelled from the letters NUBTQPHSOE, where letters can be repeated, but barring all words beginning with N. There are 271 such four-letter words in Official Scrabble Words (International Edition), and probably hundreds more if Webster's Third and the OED are dredged. Here are just a few: Bean, Best, Ebbs, Epee, Hobo, Hush, Oboe, Onus, Open, Pent, Qoph, Seen, Stop, Thus and Upon.

In the atomic number range 1000-9999, which is the first element (i.e. with lowest atomic number) whose symbol is a real word? To address this, we need to bear in mind that the initial letters of the particles increase in the order NUBTQPHSOE. In Official Scrabble Words, the element with the lowest atomic number is Unbe (atomic number 1024). But the Oxford English Dictionary weighs in with Unne (atomic number 1009); *unne* is an obsolete verb meaning "to grant or allow". In the same atomic number range, which is the last element whose symbol is a real word? In Official Scrabble Words it's Eons (atomic number 9807). Again, the Oxford English Dictionary can better this with Eese (atomic number 9979); *eese* is an obsolete form of *ease*.

Question 7 *Still in the atomic number range 1000-9999, what words can be formed as transposals of adjacent symbols?*

I have been able to find eight-letter examples, but none of twelve letters:

Botonnee Oneb-Onet 8092-8093	Nonettes Tnes-Tneo 3097-3098
Botonnee Oenb-Oent 8902-8903	Nonettes Tens-Teno 3907-3908
Botonnee Enob-Enot 9082-9083	Nonettes Ents-Ento 9037-9038
Botonnee Eonb-Eont 9802-9803	Nonettes Etns-Etno 9307-9308
Outshout Utoh-Utos 1386-1387	Potshots Tsop-Tsoh 3785-3786
Outshout Uoth-Uots 1836-1837	Potshots Tosp-Tosh 3875-3876
Outshout Tuoh-Tuos 3186-3187	Potshots Stop-Stoh 7385-7386
Outshout Touh-Tous 3816-3817	Potshots Sotp-Soth 7835-7836
Outshout Outh-Outs 8136-8137	Potshots Otsp-Otsh 8375-8376
Outshout Otuh-Otus 8316-8317	Potshots Ostp-Osth 8735-8736
Sneeshes Sehe-Sesn 7969-7970	
Sneeshes Eshe-Essn 9769-9770	

Obviously, SNEESHES is the most interesting of these, as it involves changes in the third and fourth digits of the atomic number, while the others only involve a changed fourth digit.

Question 8 *Going way beyond the first 9999 elements, what's of interest for elements 10000 and onward? Specifically, what five-letter words correspond to element symbols with the lowest and highest atomic numbers in the atomic number range 10000-99999? What about progressively longer words in each of the atomic number ranges 100...000 to 999...999?*

Length	Lowest number	Symbol/Word
5	10093	Unnet
6	100936	Unneth
7	1009367	Unneths
8	10093697	Unnethes
9	102133807	Unbuttons
10	2133802176	Buttonbush
11	39018170977	Tenuousness
12	213380217597	Buttonbushes
13	2801398170977	Bounteousness
14	79071817097797	Sensuousnesses
15	281039817097797	Bounteousnesses

Length	Highest number	Symbol/Word
5	99797	Eeses
6	903690	Eothen
7	9779097	Essenes
8	97581797	Espouses
9	977906813	Essenhout
10	9779068137	Essenhouts
11	82979097797	Obesenesses
12	823179097797	Obtusenesses
13	3901817097797	Tenuousnesses
14	79071817097797	Sensuousnesses
15	281039817097797	Bounteousnesses

Yes, I know that these are ridiculously large and unachievable atomic numbers, with the highest here being just over 281 trillion!

Can readers make any improvements on my offerings? Or find any symbols/words longer than 15 letters?

While researching and writing this article, I searched the Internet for occurrences of many of the element names referred to. The following websites both offer information o the element names above atomic number 100: www.chem.qmw.ac.uk/iupac/AtWt/element.html, and www.resource-world.net/IUPACnam.htm. But there are many others! I was surprised to find over 500 websites referring to UNNILQUADIUM, and many references for higher elements.