Elementouch^{â}
A New Three-Dimensional Periodic Table of the Elements

? A History of the Periodic Table of the Elements ?

Aside from extreme environments in the universe, all matter, including that in living organisms, is made from a combination of only about one hundred "elements." This fact alone provides a remarkable example of the profound rules and underlying order of nature. A periodic table that concisely states all of these elements is one of the most fundamental and important tools in all areas of the natural sciences.

The periodic table invented by Dmitri I. Mendeleev in 1869 has a shorter periodicity than the one widely used today. The most common table currently is a long-period table (figure below), introduced in 1905 by Alfred Werner, recipient of the 1913 Nobel Prize in chemistry for his coordination theory. It is a substantial achievement that his table, developed nearly 100 years ago, is still in widespread usage; however, there are still some shortcomings with this layout. Now, in the 21st century, after significant developments in all areas of science and technology, we propose a new periodic table of the elements: the Elementouch.

? Properties of the Elementouch ?

Although the conventional, long-periodic table is certainly the most successful incarnation, it is nevertheless not perfect. The Elementouch has succeeded in resolving some of its shortcomings.

1. All the elements are arranged continuously.

In the conventional periodic table, there is a large spacing between magnesium $_{12}$Mg and aluminum $_{13}$Al, despite the fact that these light metals have consecutive atomic numbers and similar chemical and physical properties. (The subscript number to the left of each elemental symbol is the "atomic number," representing the number of protons in the atomic nucleus.) This unnecessarily large spacing is due to the presence of *d*-electron transition-metal elements in groups three to twelve below the fourth period.

The electron orbitals around an atomic nucleus are classified by their angular momentum quantum numbers into *s, p, d,* and *f* orbitals. It is the electrons in the outermost orbitals that predominantly determine the chemical properties of each element.

The *d*-electron transition metals elements such as scandium $_{21}$Sc through zinc $_{30}$Zn have *d*-electrons in the outermost electron shells. These elements are placed at the center of the main table. In contrast, the *f*-electron transition-metal elements (lanthanoid and actinoid series) are arranged in a separate group below the main table. This arrangement causes a discontinuity between $_{56}$Ba and $_{72}$Hf. Roughly one hundred years ago, when the conventional periodic table was first introduced, the lanthanoid series with atomic numbers 57 to 71 and the actinoid series with atomic numbers 89 to 103 were considered rare. Today, however, these elements are widely used in our daily lives, in applications such as high-performance magnetic materials indispensable for many high-tech devices. These elements should be treated equally to *d*-electron transition metals and should be incorporated into the main table.

In the Elementouch, all the elements are arranged continuously according to their atomic numbers. At the same time, the *d*- and *f*-electron elements are given equal treatment.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
$_{1}$H																	$_{2}$He
$_{3}$Li	$_{4}$Be											$_{5}$B	$_{6}$C	$_{7}$N	$_{8}$O	$_{9}$F	$_{10}$Ne
$_{11}$Na	$_{12}$Mg											$_{13}$Al	$_{14}$Si	$_{15}$P	$_{16}$S	$_{17}$Cl	$_{18}$Ar
$_{19}$K	$_{20}$Ca	$_{21}$Sc	$_{22}$Ti	$_{23}$V	$_{24}$Cr	$_{25}$Mn	$_{26}$Fe	$_{27}$Co	$_{28}$Ni	$_{29}$Cu	$_{30}$Zn	$_{31}$Ga	$_{32}$Ge	$_{33}$As	$_{34}$Se	$_{35}$Br	$_{36}$Kr
$_{37}$Rb	$_{38}$Sr	$_{39}$Y	$_{40}$Zr	$_{41}$Nb	$_{42}$Mo	$_{43}$Tc	$_{44}$Ru	$_{45}$Rh	$_{46}$Pd	$_{47}$Ag	$_{48}$Cd	$_{49}$In	$_{50}$Sn	$_{51}$Sb	$_{52}$Te	$_{53}$I	$_{54}$Xe
$_{55}$Cs	$_{56}$Ba	57-71	$_{72}$Hf	$_{73}$Ta	$_{74}$W	$_{75}$Re	$_{76}$Os	$_{77}$Ir	$_{78}$Pt	$_{79}$Au	$_{80}$Hg	$_{81}$Tl	$_{82}$Pb	$_{83}$Bi	$_{84}$Po	$_{85}$At	$_{86}$Rn
$_{87}$Fr	$_{88}$Ra	89-103	$_{104}$Rf	$_{105}$Db	$_{106}$Sg	$_{107}$Bh	$_{108}$Hs	$_{109}$Mt	110	111	112						

$_{57}$La	$_{58}$Ce	$_{59}$Pr	$_{60}$Nd	$_{61}$Pm	$_{62}$Sm	$_{63}$Eu	$_{64}$Gd	$_{65}$Tb	$_{66}$Dy	$_{67}$Ho	$_{68}$Er	$_{69}$Tm	$_{70}$Yb	$_{71}$Lu
$_{89}$Ac	$_{90}$Th	$_{91}$Pa	$_{92}$U	$_{93}$Np	$_{94}$Pu	$_{95}$Am	$_{96}$Cm	$_{97}$Bk	$_{98}$Cf	$_{99}$Es	$_{100}$Fm	$_{101}$Md	$_{102}$No	$_{103}$Lr

Conventional long-period periodic table of the elements

2. Visual depiction of electron orbitals

Viewed from the top, the Elementouch resembles a simplified model of an atom with different electron orbitals around the nucleus. The three circular surfaces represent the orbitals: *s*- and *p*-electron elements are placed on the inner cylinder, *d*-electron elements in the middle cylinder, and *f*-electron elements on the outer cylinder. As a result, the helix on three circular surfaces depicts the electrons filling the *s/p*, *d*, and *f* orbitals.

Elementouch used as a pen stand.

3. Improved grouping of materials properties

When we try to synthesize new materials, it is important to know which elements have similar physical and chemical properties. Elementouch helps identify these by arranging similar elements in the same vertical column.

For example, a new superconductor has been found by replacing cadmium (Cd) for calcium (Ca). Both tend to be divalent (+2) ions and have a nearly identical ionic radius. These elements belong to group 2 and group 12, respectively; these used to be referred to as group 2A and 2B because of their valence tendency. In fact, the elements in these two groups were arranged in one column in Mendeleev's original periodic table, since he expressed the most stable valence state of each element when it forms an oxide. As a further example, $_{22}$Ti in group 4 and $_{50}$Sn in group 13, both of which prefer tetravalent (+4) ionic states, are in seemingly unrelated places in the conventional periodic table.

Lutetium $_{71}$Lu does not exhibit any magnetism when it becomes a trivalent ion. In this sense, unlike other *f*-electron elements, Lu is rather similar to nonmagnetic $_{39}$Y and $_{57}$La. The conventional long periodic table cannot express this property explicitly.

In the Elementouch, elements which prefer divalent (+2), trivalent (+3), and tetravalent (+4) ionic states are arranged in the same respective columns. Typical elements and transition elements are classified with different colors.

The Elementouch improves the groupings of elements based on their properties in materials; for the examples above, Ca and Cd, Ti and Sn, and Y, La, and Lu are arranged in the same columns.

? Colors of the Elementouch ?

Element names are colored according to their properties:

1. *s*-electron elements: sky blue
2. *p*-electron elements: sand yellow
3. rare-gas elements: pink
4. *d*-electron transition-metal elements: marine blue
5. *f*-electron transition-metal elements: coral green

? Use of the Elemmentouch ?

1. A scientific decoration for the home or office
2. A pen stand with a scientific bent
3. Educational material for use in a science class
4. Commemorative high-school graduation gifts
5. Souvenirs for scientific conferences
6. Novelties for companies dealing in scientific products

? Origin of the name "Elementouch®" ?

The name "Elementouch" originates from "touching the elements", as well as from a Japanese word "tate" (longer in vertical direction) and another Japanese word "tatchi" (an infant word for "standing"). A pen stand is "pen tate" in Japanese.

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The sales of this product have been authorized to Ohya Sangyo Co., Ltd. by Professor. Y. Maeno through Technology Management Department (TMD) of Recruit Co., Ltd.