General Theory of electronic configuration of atoms

Claude Ziad Bayeh
EEE GROUP-R&D Department-LEBANON

Abstract: *The "General Theory of electronic configuration of atoms" is an original study introduced by the author in chemistry in 2004. In this paper, the author developed a new method to write the electronic configuration for any atom, regardless of whether it actually exists or not in nature. This new method is based on Quantum theory and on three new and original formulae introduced and developed by the author. This method can be used to gather information about any atom's properties: its period, its group, its peripheral number of electrons and its theoretical electronic peripheral configuration. The main advantage of this method is that one can immediately knows the information about an atom, by a simple hand calculation without the need of software. Even if the atomic number is huge (as Z=123453). This method can be used in general chemistry courses and it is an extremely efficient method used for teaching and in the exam.*

So any atomic number can be developed and we can find its electronic configuration regardless of whether it actually exists or not in nature.

-The traditional method of writing an electronic configuration is like this

$\overbrace{1S^2}\overbrace{2S^22P^6}\overbrace{3S^23P^6}\overbrace{4S^23D^{10}3P^6}\overbrace{5S^24D^{10}5P^6}\overbrace{6S^24F^{14}5D^{10}6P^6}$ ... *Until finding the peripheral electronic configuration.*

So the new method developed in this paper is mainly works on the peripheral electronic configuration without passing through the traditional method. It gives us directly the peripheral electronic configuration, for example

$\overbrace{6S^24F^{14}5D^{10}6P^6}$.

In this way we have eliminated a very long process of calculation. This is a big advantage for the proposed method ahead the traditional one.

The main goal of introducing this paper is to reduce the calculation of obtaining the main information about an atom for example its period, group, number of electrons in the peripheral configuration and finding its peripheral electronic configuration as fast as possible even if the atom doesn't exist in reality. This paper doesn't explain the relativistic effects, because it is not the main goal of the proposed theory. We can still obtain the information about any atom without considering the relativistic effects.

Keywords: *Electronic configuration, quantum theory, orbital, atom, electron.*

I. Introduction

In the past, many scientists and researchers have developed several methods in order to calculate the electronic configuration of atoms [1, 11, 15, and 19]. These methods are very important and efficient, but the main problem is how to use a simple method of calculation without necessary software, and still get accurate results as fast as possible [20, 21, 22, and 23]. This issue is now eliminated by a new method introduced and developed by the author. The concept of this method is based on three new formulae developed by the author in order to facilitate the calculation.

Moreover, this method gives birth to a new periodic table based on the theory, and the calculation which the name is "Bayeh's theoretical periodic table". This method can be used in general chemistry courses (especially in Quantum Chemistry) to calculate any electronic configuration even in some cases where it is impossible using the traditional methods.

In the second section, an overview on the general theory of electronic configuration is presented. Then in the third section , a theorem of ground state electron configuration is developed. In the fourth section, a calculation of the period of an element is introduced. In the section 5, some applicable examples are given in order to understand the theory. In sections 6 and 7, the theory is programmed in C++ language and in Visual Basic.NET with some examples. In the section 8, a formulation of the theoretical periodic table is developed. Finally the conclusion is presented in the section 9.

II. Overview On The General Theory Of Electronic Configuration Of Atoms

In this section, a simple example is introduced with an explanation in order to allow the reader to easily understand the upcoming theoretical part. The theory that was initially introduced by the author was also adapted by many advanced professors in the field; moreover they used it as a very reliable tool to help the

students understand exactly how the configuration of electrons work and how to calculate the number of electrons, the period and the electronic configuration without using any software.

Example with Atomic number equal to Z=203

There exist only four steps that determine the period of the atom, the number of its peripheral electrons, the group of the atom and the ground state electron configuration:

Step 1:
By applying the equation (6) in the section 4.1, we have to verify the equality

$$\sum_{i=2}^{\sqrt{N}} i^2(P) == \frac{Z-2}{2} = \frac{203-2}{2} = 100.5$$

Where $P = 1$ or $P = 2$.
i Is a variable that takes values from 2 to $\sqrt{N}$, and it is an image of the orbital that contains electrons.
N Represents the last orbital containing peripheral electrons.

Step 2:
This step helps us determine which equation to apply amongst the equations 13, 14, 15 or 16 presented in the section 4.2.

•Firstly, one has to calculate the sum $2 * 2^2 + 2 * 3^2 + 2 * 4^2 \ldots (P) * \sqrt{N}^2$ that must be less or equal to

$$\sum_{i=2}^{\sqrt{N}} i^2(P) = 100.5$$

E.g.: $(2 * 2^2 + 2 * 3^2 + 2 * 4^2 + 1 * 5^2) = 83 < \frac{Z-2}{2} = 100.5$

•then, calculate the sum $2 * 2^2 + 2 * 3^2 + 2 * 4^2 \ldots (P) * \sqrt{N}^2$ that must be greater or equal to $\sum_{i=2}^{\sqrt{N}} i^2(P) = 100.5$
E.g.: $(2 * 2^2 + 2 * 3^2 + 2 * 4^2 + 2 * 5^2) = 108 > \frac{Z-2}{2} = 100.5$

These two equations above can be written in one equation as the following

$$\sum_{i=2}^{\sqrt{N}} i^2(P) == \begin{cases} 2 * 2^2 + 2 * 3^2 + 2 * 4^2 + 1 * 5^2 = 83 < \dfrac{Z-2}{2} = 100.5 \\ 2 * 2^2 + 2 * 3^2 + 2 * 4^2 + (P=2) * 5^2 = 108 > \dfrac{Z-2}{2} = 100.5 \end{cases}$$

In this case we can deduce that P is equal to 2 because it is the last number that is multiplied by 5 which is the image of the last orbital.
Once the value of P is found, the period of the element is easily deduced, by the following method (that will be explained later);
Setting $v = P + 1 = 3$ and $n = 2i - v; P; (2)/(1)$
$\Rightarrow n = 2 * 5 - 1 = 9$ Which is the period of the atom, therefore the period is odd.

Step 3:
In this step, the number of peripheral electrons is obtained, and this number also determines the number of electrons remaining in the last orbital.
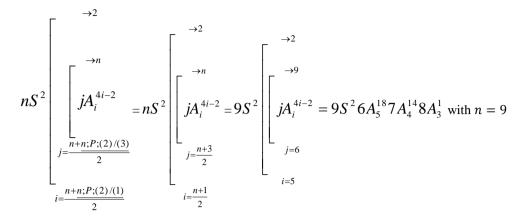Calculation of the number of peripheral electrons will be as the following;

$$N_{pe} = Z - \left(2 + 2 \sum_{i=2}^{\sqrt{N}} i^2(P) \right) = 203 - \left(2 + 2 \left(\sum_{i=2}^{5} i^2(P) \right) \right)$$
$$= 203 - (2 + 2(2 * 2^2 + 2 * 3^2 + 2 * 4^2 + 1 * 5^2) = 35$$

Therefore the Number of peripheral electrons is equal to $N_{pe} = 35$.

Step 4:
The final step is to write the electron configuration of the last line (ground state electron configuration). As the number of peripheral electron as well as the period is given, one can easily find the electron configuration. The following formulae will be developed in the following sections.

$$nS^2 \left[\begin{array}{c} {\scriptstyle \to n} \\ jA_i^{4i-2} \\ {\scriptstyle j=\frac{n+n;P;(2)/(3)}{2}} \end{array} \right]_{\substack{{\scriptstyle \to 2} \\ {\scriptstyle i=\frac{n+n;P;(2)/(1)}{2}}}} = nS^2 \left[\begin{array}{c} {\scriptstyle \to n} \\ jA_i^{4i-2} \\ {\scriptstyle j=\frac{n+3}{2}} \end{array} \right]_{\substack{{\scriptstyle \to 2} \\ {\scriptstyle i=\frac{n+1}{2}}}} = 9S^2 \left[\begin{array}{c} {\scriptstyle \to 9} \\ jA_i^{4i-2} \\ {\scriptstyle j=6} \end{array} \right]_{\substack{{\scriptstyle \to 2} \\ {\scriptstyle i=5}}} = 9S^2 \, 6A_5^{18} \, 7A_4^{14} \, 8A_3^1 \text{ with } n = 9$$

Briefly the Atom with Z=203 has the following characteristic
- o Period n=9
- o Number of peripheral electrons $N_{pe} = 35$
- o Group is $D^9 = A_3^1$ (its location is presented on the picture below)
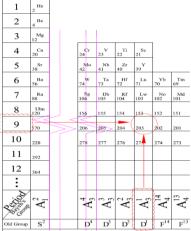

Fig. 1: The Atom with Z=203 is presented in the circle, it is in the period 9 and group D^1 or A_3^1 of the Bayeh's theoretical periodic table of elements.

III. Theorem Of The Ground State Electron Configuration

Examples of the theorem will follow beginning in section 5.

Let's consider the following orbital: $S^2 P^6 D^{10} F^{14} G^{18} H^{22} I^{26} J^{30} K^{34} L^{38} M^{42} N^{46} \ldots \ldots A_n^{2+4(n-1)}$

in which the inferior index n of $A_n^{2+4(n-1)}$ indicates the period of the atom and the superior index (2+4(n-1)) indicates the maximum number of electron on the orbital $A_n^{2+4(n-1)}$.

1 S^2
2 $S^2 P^6$
3 $S^2 P^6 D^{10}$
4 $S^2 P^6 D^{10} F^{14}$
5 $S^2 P^6 D^{10} F^{14} G^{18}$
6 $S^2 P^6 D^{10} F^{14} G^{18} H^{22}$
7 $S^2 P^6 D^{10} F^{14} G^{18} H^{22} I^{26}$
8 $S^2 P^6 D^{10} F^{14} G^{18} H^{22} I^{26} J^{30}$
9 $S^2 P^6 D^{10} F^{14} G^{18} H^{22} I^{26} J^{30} K^{34}$
10 $S^2 P^6 D^{10} F^{14} G^{18} H^{22} I^{26} J^{30} K^{34} L^{38}$
11 $S^2 P^6 D^{10} F^{14} G^{18} H^{22} I^{26} J^{30} K^{34} L^{38} M^{42}$
12 $S^2 P^6 D^{10} F^{14} G^{18} H^{22} I^{26} J^{30} K^{34} L^{38} M^{42} N^{46}$
...
...

n S^2…………………………………………………… $A_n^{2+4(n-1)}$

The general orbital formulae is $A_n^{2+4(n-1)}$

In fact, for

n=1, $A_n^{2+4(n-1)} = S^2$

n=2, $A_n^{2+4(n-1)} = P^6$

n=3, $A_n^{2+4(n-1)} = D^{10}$ and so on.

•The complete ground state electron configuration is:

$$\overbrace{1S^2}^{\substack{2\\2}} \overbrace{2S^22P^6}^{\substack{10\\8}} \overbrace{3S^23P^6}^{\substack{18\\8}} \overbrace{4S^23D^{10}3P^6}^{\substack{36\\18}} \overbrace{5S^24D^{10}5P^6}^{\substack{54\\18}} \overbrace{6S^24F^{14}5D^{10}6P^6}^{\substack{86\\32}} \overbrace{7S^25F^{14}6D^{10}7P^6}^{\substack{118\\32}} \overbrace{8S^25G^{18}6F^{14}7D^{10}8P^6}^{\substack{168\\50}}$$

$$\overbrace{9S^26G^{18}7F^{14}8D^{10}9P^6}^{\substack{218\\50}} \overbrace{10S^26H^{22}7G^{18}8F^{14}9D^{10}10P^6}^{\substack{290\\72}} \overbrace{11S^27H^{22}8G^{18}9F^{14}10D^{10}11P^6}^{\substack{362\\72}}$$

$$\overbrace{12S^27I^{26}8H^{22}9G^{18}10F^{14}11D^{10}12P^6}^{\substack{460\\98}} \overbrace{13S^28I^{26}9H^{22}10G^{18}11F^{14}12D^{10}13P^6}^{\substack{558\\98}} \ldots \overbrace{nS^2\ldots\ldots nP^6}^{\substack{\text{Sum of electrons of the precedent brackets}\\ \text{maximum nb of electron on each bracket}}}$$

Remark: *Bracket* in English has the same meaning of *Line* in French

•In order to shorten and simplify the demonstration, and unify all these shells and electron configurations, the author have introduced and developed new and original formulae that will be presented in the following paragraphs; these formulae are used in order to write all electron configurations in one formula.
The following formulae are deduced from the complete electronic configuration (ground state electron configuration) with a complete number of electrons:

1- If the period is an even number then

$$nS^2 \left[\begin{array}{c} \xrightarrow{2} \\ \left[\begin{array}{c} \xrightarrow{n} \\ jA_i^{4i-2} \ ; \ i = \frac{n+2}{2} \to 2 \text{ and } j = \frac{n+2}{2} \to n; \text{ with } n \geq 2 \text{ and } n \text{ is an even number, } n \in N^* \\ j=\frac{n+2}{2} \end{array} \right] \\ i=\frac{n+2}{2} \end{array} \right. \qquad (1)$$

where

i is going from $\frac{n+2}{2}$ to 2.

j is going from $\frac{n+2}{2}$ to n.

The parameters i and j vary sinultaneously. The parameter i is decreasing by 1 until it is equal to 2, and j is increasing by 1 until it is equal to n.

For a complete ground state electron configuration, this formula will become as the following (all electrons are presented):

$$nS^2\left[\begin{array}{c}\stackrel{\rightarrow 2}{}\\[4pt]\left[\begin{array}{c}\stackrel{\rightarrow n}{}\\[4pt]jA_i^{4i-2}\\[4pt]{\scriptstyle j=\frac{n+2}{2}}\end{array}\right.\\[4pt]{\scriptstyle i=\frac{n+2}{2}}\end{array}\right. = nS^2\,(\tfrac{n+2}{2})A_{\frac{n+2}{2}}^{4\frac{n+2}{2}-2}\,(\tfrac{n+2}{2}+1)A_{i-1}^{4(\frac{n+2}{2}-1)-2}\,(\tfrac{n+2}{2}+2)A_{i-2}^{4(\frac{n+2}{2}-2)-2}\,(\tfrac{n+2}{2}+3)A_{i-1}^{4(\frac{n+2}{2}-3)-2}......nP^6$$

Examples:

For $n=6 \Rightarrow$ $nS^2\left[\begin{array}{c}\stackrel{\rightarrow 2}{}\\[4pt]\left[\begin{array}{c}\stackrel{\rightarrow n}{}\\[4pt]jA_i^{4i-2}=6S^2\\[4pt]{\scriptstyle j=\frac{n+2}{2}}\end{array}\right.\\[4pt]{\scriptstyle i=\frac{n+2}{2}}\end{array}\right.\left[\begin{array}{c}\stackrel{\rightarrow 2}{}\\[4pt]\left[\begin{array}{c}\stackrel{\rightarrow 6}{}\\[4pt]jA_i^{4i-2}=6S^2 4F^{14}5D^{10}6P^6\\[4pt]{\scriptstyle j=4}\end{array}\right.\\[4pt]{\scriptstyle i=4}\end{array}\right.$

For $n=8 \Rightarrow$ $nS^2\left[\begin{array}{c}\stackrel{\rightarrow 2}{}\\[4pt]\left[\begin{array}{c}\stackrel{\rightarrow n}{}\\[4pt]jA_i^{4i-2}=8S^2\\[4pt]{\scriptstyle j=\frac{n+2}{2}}\end{array}\right.\\[4pt]{\scriptstyle i=\frac{n+2}{2}}\end{array}\right.\left[\begin{array}{c}\stackrel{\rightarrow 2}{}\\[4pt]\left[\begin{array}{c}\stackrel{\rightarrow 8}{}\\[4pt]jA_i^{4i-2}=8S^2 5A_5^{18}6A_4^{14}7A_3^{10}8A_2^6\\[4pt]{\scriptstyle j=5}\end{array}\right.\\[4pt]{\scriptstyle i=5}\end{array}\right.$

For $n=10 \Rightarrow$ $10S^2\left[\begin{array}{c}\stackrel{\rightarrow 2}{}\\[4pt]\left[\begin{array}{c}\stackrel{\rightarrow 10}{}\\[4pt]jA_i^{4i-2}=10S^2 6A_6^{22}7A_5^{18}8A_4^{14}9A_3^{10}10A_2^6=10S^2 6H^{22}7G^{18}8F^{14}9D^{10}10P^6\\[4pt]{\scriptstyle j=6}\end{array}\right.\\[4pt]{\scriptstyle i=6}\end{array}\right.$

2- If the period is an odd number then

$$nS^2\left[\begin{array}{c}\stackrel{\rightarrow 2}{}\\[4pt]\left[\begin{array}{c}\stackrel{\rightarrow n}{}\\[4pt]jA_i^{4i-2}\\[4pt]{\scriptstyle j=\frac{n+3}{2}}\end{array}\right.\\[4pt]{\scriptstyle i=\frac{n+1}{2}}\end{array}\right. \quad ; \ i = \frac{n+1}{2} \blacktriangleright 2 \text{ and } j = \frac{n+3}{2} \blacktriangleright \text{ n; with } n \geq 1 \text{ and n is an odd number, } n \in N^* \qquad (2)$$

Where

i is going from $\frac{n+1}{2}$ to 2.

j is going from $\frac{n+3}{2}$ to n.

The parameters i and j vary simultaneously; The parameter i is decreasing by 1 until it is equal to 2, and j is increasing by 1 until it is equal to n.

For a complete ground state electron configuration the form of this formula will be as the following (all electrons are presented):

$$nS^2\left[\overset{\to 2}{\underset{i=\frac{n+1}{2}}{\left[\overset{\to n}{\underset{j=\frac{n+3}{2}}{jA_i^{4i-2}}}\right]}}\right] = nS^2\left(\tfrac{n+3}{2}\right)A_{\frac{n+1}{2}}^{4\frac{n+1}{2}-2}\left(\tfrac{n+3}{2}+1\right)A_{\frac{n+1}{2}-1}^{4(\frac{n+1}{2}-1)-2}\left(\tfrac{n+3}{2}+2\right)A_{\frac{n+1}{2}-2}^{4(\frac{n+1}{2}-2)-2}\left(\tfrac{n+3}{2}+3\right)A_{\frac{n+1}{2}-3}^{4(\frac{n+1}{2}-3)-2}\left(\tfrac{n+3}{2}+4\right)A_{\frac{n+1}{2}-4}^{4(\frac{n+1}{2}-4)-2}......nP^6$$

Examples:

For $n=5 \Rightarrow nS^2\left[\overset{\to 2}{\underset{i=\frac{n+1}{2}}{\left[\overset{\to n}{\underset{j=\frac{n+3}{2}}{jA_i^{4i-2}}}\right]}}\right] = 5S^2\left[\overset{\to 2}{\underset{i=3}{\left[\overset{\to 5}{\underset{j=4}{jA_i^{4i-2}}}\right]}}\right] = 5S^2 4D^{10} 5P^6$

For $n=11 \Rightarrow 11S^2\left[\overset{\to 2}{\underset{i=6}{\left[\overset{\to 11}{\underset{j=7}{jA_i^{4i-2}}}\right]}}\right] = 11S^2 7A_6^{22} 8A_5^{18} 9A_4^{14} 10A_3^{10} 11A_2^{6} = 11S^2 7H^{22} 8G^{18} 9F^{14} 10D^{10} 11P^6$

The two formulae presented above can be written in one formula using a function named "*INFOMATH function*" which also an original formula introduced by the author [26].

The general formula of the complete ground state electron configuration is written as the following:

$$nS^2\left[\overset{\to 2}{\underset{i=\frac{n+n;P;(2)/(1)}{2}}{\left[\overset{\to n}{\underset{j=\frac{n+n;P;(2)/(3)}{2}}{jA_i^{4i-2}}}\right]}}\right] \qquad (3)$$

In the equation (3) there are two *INFOMATH functions* as following:

• $\underline{n;P;(2)/(1)}$ is an *INFOMATH function* and can be read as the following:

If *n* is an even number, then $\underline{n;P;(2)/(1)} = 2$, else $\underline{n;P;(2)/(1)} = 1$

Therefore, if *n* is an even number, $i = \dfrac{n+2}{2}$, else $i = \dfrac{n+1}{2}$, just replace the value in the equation of $i = \dfrac{n+\underline{n;P;(2)/(1)}}{2}$.

• $\underline{n;P;(2)/(3)}$ is an *INFOMATH function* and can be read as the following:

If *n* is an even number, then $\underline{n;P;(2)/(3)} = 2$, else $\underline{n;P;(2)/(3)} = 3$

Therefore, if *n* is even, $j = \dfrac{n+2}{2}$, else $j = \dfrac{n+3}{2}$ just replace the value in the equation of $j = \dfrac{n+\underline{n;P;(2)/(3)}}{2}$.

So, if n is even,

$$nS^2 \left[\overset{\to 2}{\underset{i=\frac{n+\underline{n;P;(2)/(1)}}{2}}{\left[\overset{\to n}{\underset{j=\frac{n+\underline{n;P;(2)/(3)}}{2}}{jA_i^{4i-2}}} \right]}} \right] = nS^2 \left[\overset{\to 2}{\underset{i=\frac{n+2}{2}}{\left[\overset{\to n}{\underset{j=\frac{n+2}{2}}{jA_i^{4i-2}}} \right]}} \right], \text{ else } nS^2 \left[\overset{\to 2}{\underset{i=\frac{n+\underline{n;P;(2)/(1)}}{2}}{\left[\overset{\to n}{\underset{j=\frac{n+\underline{n;P;(2)/(3)}}{2}}{jA_i^{4i-2}}} \right]}} \right] = nS^2 \left[\overset{\to 2}{\underset{i=\frac{n+1}{2}}{\left[\overset{\to n}{\underset{j=\frac{n+3}{2}}{jA_i^{4i-2}}} \right]}} \right]$$

This verifies the equation (3)

IV. Calculattion Of The Period Of An Element

In order to know the ground state configuration, one must know the period (n) of the element. The following method allows knowing the period of the element, and therefore its ground state configuration. The complete electronic configuration is:

$$\overset{\overset{2}{2}}{\overbrace{1S^2}} \overset{\overset{10}{8}}{\overbrace{2S^2 2P^6}} \overset{\overset{18}{8}}{\overbrace{3S^2 3P^6}} \overset{\overset{36}{18}}{\overbrace{4S^2 3D^{10} 3P^6}} \overset{\overset{54}{18}}{\overbrace{5S^2 4D^{10} 5P^6}} \overset{\overset{86}{32}}{\overbrace{6S^2 4F^{14} 5D^{10} 6P^6}} \overset{\overset{118}{32}}{\overbrace{7S^2 5F^{14} 6D^{10} 7P^6}} \overset{\overset{168}{50}}{\overbrace{8S^2 5G^{18} 6F^{14} 7D^{10} 8P^6}}$$

$$\overset{\overset{218}{50}}{\overbrace{9S^2 6G^{18} 7F^{14} 8D^{10} 9P^6}} \overset{\overset{290}{72}}{\overbrace{10S^2 6H^{22} 7G^{18} 8F^{14} 9D^{10} 10P^6}} \overset{\overset{362}{72}}{\overbrace{11S^2 7H^{22} 8G^{18} 9F^{14} 10D^{10} 11P^6}}$$

$$\overset{\overset{460}{98}}{\overbrace{12S^2 7I^{26} 8H^{22} 9G^{18} 10F^{14} 11D^{10} 12P^6}} \overset{\overset{558}{98}}{\overbrace{13S^2 8I^{26} 9H^{22} 10G^{18} 11F^{14} 12D^{10} 13P^6}} \dots \quad \overset{\text{Sum of electrons of the precedent brackets}}{\underset{\text{maximum nb of electron on each bracket}}{\overbrace{nS^2 \dots \dots nP^6}}}$$

The maximal sum of the electrons on each line till the peripheral line is as the following:

S= 2+8+8+18+18+32+32+50+50+72+72+98+98+128+128+162+162…+N+N (or just one N)

$\quad$ =2+2*8+2*18+2*32+2*50+2*72+2*98+2*128+2*162+2*200+……+ (1 or 2)*N

$\quad$ =2+2(8+18+32+50+72+98+128+162+200+….+(N-1))+ (1 or 2)*N

$\quad$ =2+2(2*2^2+2*3^2+2*4^2+2*5^2+2*6^2+2*7^2+2*8^2+2*9^2+…+2*$\left(\sqrt{\dfrac{N-1}{2}}\right)^2$) + (1 or 2) * $\left(\sqrt{N}\right)^2$

$\quad$ =$2 + 2\left(2*2^2 + 2*3^2 + 2*4^2 + 2*5^2 + 2*6^2 + \cdots + 2*\left(\sqrt{\dfrac{N-1}{2}}\right)^2\right) + (1 \text{ or } 2)*\left(\sqrt{N}\right)^2$

$\quad$ =$2 + 2\sum_{i=2}^{\sqrt{N}} i^2 (1 \text{ or } 2)$

Let's consider that $P = (1 \text{ or } 2)$, then $S = 2 + 2\sum_{i=2}^{\sqrt{N}} i^2 (P)$ $\hspace{3cm}$ (4)

Having N as the number of electrons on the last line
•If the period n is odd, then $n = 2i - 1$
•If the period n is even, then $n = 2(i - 1)$

These two formulae can be written in one formula by using the "*INFOMATH function*". Therefore, $n = 2i - \underline{v; P; (2)/(1)}$, with $v = P + 1$.

IV.1. How to calculate P
If the atomic number is given, equation (4) can be compared with the atomic number by the following equation:

$$Z == 2 + 2 \sum_{i=2}^{\sqrt{N}} i^2(P) \tag{5}$$

The two equal signs (= =) indicate the comparison and verification of the number Z with the formula. Therefore:

$$\sum_{i=2}^{\sqrt{N}} i^2(P) == \frac{Z-2}{2} \tag{6}$$

This formula gives two equations in which the atomic number will be situated in between the sum of each equation.

$$\sum_{i=2}^{\sqrt{N}} i^2(P) = \begin{cases} 2*2^2 + 2*3^2 + 2*4^2 + 2*5^2 + \cdots + 2*\left(\sqrt{\frac{N-1}{2}}\right)^2 + r*\left(\sqrt{N}\right)^2 & (Inferior\ sum) \\ 2*2^2 + 2*3^2 + 2*4^2 + 2*5^2 + \cdots + 2*\left(\sqrt{\frac{N-1}{2}}\right)^2 + (r+1)*\left(\sqrt{N}\right)^2 & (Superior\ sum) \end{cases} \tag{7}$$

Or it can be written in one equation:

$$\sum_{i=2}^{\sqrt{N}} i^2(P) = 2*2^2 + 2*3^2 + 2*4^2 + 2*5^2 + \cdots + 2*\left(\sqrt{\frac{N-1}{2}}\right)^2 + (P)*\left(\sqrt{N}\right)^2\ (Superior\ sum) \tag{8a}$$

With r will take one of the two values ($r = 0\ or\ r = 1$) and $P = r + 1$
For $r = 0, P = 1$ therefore:

$$\sum_{i=2}^{\sqrt{N}} i^2(P) = 2*2^2 + 2*3^2 + \cdots + 2*\left(\sqrt{\frac{N-1}{2}}\right)^2 + (1)*\left(\sqrt{N}\right)^2 (Superior\ sum) \tag{8b}$$

For $r = 1, P = 2$ therefore:

$$\sum_{i=2}^{\sqrt{N}} i^2(P) = 2*2^2 + 2*3^2 + \cdots + 2*\left(\sqrt{\frac{N-1}{2}}\right)^2 + (2)*\left(\sqrt{N}\right)^2 (Superior\ sum) \tag{8c}$$

In order to find P, one must look at the *Superior sum* and not at the *Inferior sum*. For this reason the following method contains 4 equations that verify the equality of the equation (6).

First equation:

$$\sum_{i=2}^{\sqrt{N}} i^2(P) = \begin{cases} 2*2^2 + 2*3^2 + 2*4^2 + 2*5^2 + \cdots + 2*\left(\sqrt{\frac{N-1}{2}}\right)^2 & (Inferior\ sum) \\ 2*2^2 + 2*3^2 + 2*4^2 + 2*5^2 + \cdots + 2*\left(\sqrt{\frac{N-1}{2}}\right)^2 + 1*\left(\sqrt{N}\right)^2 & (Superior\ sum) \end{cases} \tag{9}$$

With $P = 1$, thus $v = P + 1 = 2$ and $r = P - 1 = 0$.

Second equation:

$$\sum_{i=2}^{\sqrt{N}} i^2(P) = \begin{cases} 2*2^2 + 2*3^2 + 2*4^2 + 2*5^2 + \cdots + 2*\left(\sqrt{\frac{N-1}{2}}\right)^2 + 1*\left(\sqrt{N}\right)^2 \; (Inferior\; sum) \\[4mm] 2*2^2 + 2*3^2 + 2*4^2 + 2*5^2 + \cdots + 2*\left(\sqrt{\frac{N-1}{2}}\right)^2 + 2*\left(\sqrt{N}\right)^2 \; (Superior\; sum) \end{cases}$$

(10)

With $P = 2$, thus $v = P + 1 = 3$ and $r = P - 1 = 1$.

Third equation:

$$\sum_{i=2}^{\sqrt{N}} i^2(P) = \begin{cases} 2*2^2 + 2*3^2 + 2*4^2 + 2*5^2 + \cdots + 2*\left(\sqrt{\frac{N-1}{2}}\right)^2 + 1*\left(\sqrt{N}\right)^2 \; (Superior\; sum) \end{cases}$$

(11)

With $P = 1$, thus $v = P + 1 = 2$ and $r = P - 1 = 0$.

Fourth equation:

$$\sum_{i=2}^{\sqrt{N}} i^2(P) = \begin{cases} 2*2^2 + 2*3^2 + 2*4^2 + 2*5^2 + \cdots + 2*\left(\sqrt{\frac{N-1}{2}}\right)^2 + 2*\left(\sqrt{N}\right)^2 \; (Superior\; sum) \end{cases}$$

(12)

With $P = 2$, thus $v = P + 1 = 3$ and $r = P - 1 = 1$.

Briefly, To find the value of "P", always look at the ($Superior\; sum$), the following cases will appear:

-If $2*2^2 + 2*3^2 + 2*4^2 + \cdots + 2*\left(\sqrt{\frac{N-1}{2}}\right)^2 + 1*\left(\sqrt{N}\right)^2 \geq \frac{Z-2}{2}$ therefore, $P = 1$

-If the $2*2^2 + 2*3^2 + 2*4^2 + \cdots + 2*\left(\sqrt{\frac{N-1}{2}}\right)^2 + 2*\left(\sqrt{N}\right)^2 \geq \frac{Z-2}{2}$ therefore, $P = 2$

IV.2. Calculate *P* from the Atomic number

If the atomic number (Z) is given, therefore the equation (5) and (6) are used,

In fact $\sum_{i=2}^{\sqrt{N}} i^2(P) == \frac{Z-2}{2}$ this equation leads to four different results as in equations 9, 10, 11 and 12. Therefore,

• First case:

$$\sum_{i=2}^{\sqrt{N}} i^2(P) == \begin{cases} 2*2^2 + 2*3^2 + 2*4^2 + 2*5^2 + \cdots + 2*\left(\sqrt{\frac{N-1}{2}}\right)^2 < \frac{Z-2}{2} \\[4mm] 2*2^2 + 2*3^2 + 2*4^2 + 2*5^2 + \cdots + 2*\left(\sqrt{\frac{N-1}{2}}\right)^2 + 1*\left(\sqrt{N}\right)^2 > \frac{Z-2}{2} \end{cases}$$

(13)

With $P = 1$, thus $v = P + 1 = 2$ and $r = P - 1 = 0$.

The value of P can be find directly in the ($Superior\; sum$) of the equation (13) in which it takes the value that equals to 1 in $(1 * \left(\sqrt{N}\right)^2)$.

In this case, $n = 2i - v; P; (2)/(1)$, with $v = P + 1 = 2$.

$n = 2i - v; P; (2)/(1) = 2i - 2 = 2(i - 1)$ this indicates that the period is even.

The same applies on the value of i in which it takes the value of $\sqrt{N}$ (the last number in the equation (13), which represents the number of electrons in the last (Bracket) line).

$n = 2i - v; P; (2)/(1) = 2i - 2 = 2(i - 1) = 2\left(\sqrt{N} - 1\right)$

• Second case:

$$\sum_{i=2}^{\sqrt{N}} i^2 (P) == \begin{cases} 2*2^2 + 2*3^2 + 2*4^2 + 2*5^2 + \cdots + 1*\left(\sqrt{N}\right)^2 < \frac{Z-2}{2} \\ 2*2^2 + 2*3^2 + 2*4^2 + 2*5^2 + \cdots + 2*\left(\sqrt{N}\right)^2 > \frac{Z-2}{2} \end{cases} \quad (14)$$

With $P = 2$, thus $v = P + 1 = 3$ and $r = P - 1 = 1$.

The value of P can be find directly in the (*Superior sum*) of the equation (14) in which it takes the value equal to 2 in $(2 * \left(\sqrt{N}\right)^2)$.

In this case, $n = 2i - \underline{v; P; (2)/(1)}$, with $v = P + 1 = 3$.
$n = 2i - \underline{v; P; (2)/(1)} = 2i - 1$ this indicates that the period is odd.
The same applies on the value of i which takes the value of $\sqrt{N}$ (the last number in the equation (14), which represents the number of electrons in the last (bracket) line).
$n = 2i - \underline{v; P; (2)/(1)} = 2i - 1 = 2i - 1 = 2\sqrt{N} - 1$

• Third case:

$$\sum_{i=2}^{\sqrt{N}} i^2 (P) == \left\{ 2*2^2 + 2*3^2 + 2*4^2 + 2*5^2 + \cdots + 2*\left(\sqrt{\frac{N-1}{2}}\right)^2 + 1*\left(\sqrt{N}\right)^2 = \frac{Z-2}{2} \right. \quad (15)$$

With $P = 1$, thus $v = P + 1 = 2$ and $r = P - 1 = 0$.

The value of P can be found directly in the (*Superior sum*) of the equation (15) in which it takes the value equal to 1 in $(1 * \left(\sqrt{N}\right)^2)$.

In this case, $n = 2i - \underline{v; P; (2)/(1)}$, with $v = P + 1 = 2$.
$n = 2i - \underline{v; P; (2)/(1)} = 2i - 2 = 2(i - 1)$ this indicates that the period is even.
The same applies on the value of i which takes the value of $\sqrt{N}$ (the last number which represents the number of electrons in the last (bracket) line).
$n = 2i - \underline{v; P; (2)/(1)} = 2i - 2 = 2(i - 1) = 2\left(\sqrt{N} - 1\right)$

• Fourth case:

$$\sum_{i=2}^{\sqrt{N}} i^2 (P) == \left\{ 2*2^2 + 2*3^2 + 2*4^2 + 2*5^2 + \cdots + 2*\left(\sqrt{\frac{N-1}{2}}\right)^2 + 2*\left(\sqrt{N}\right)^2 = \frac{Z-2}{2} \right. \quad (16)$$

With $P = 2$, thus $v = P + 1 = 3$ and $r = P - 1 = 1$.

The value of P can be found directly in the (*Superior sum*) of the equation (16) in which it takes the value equal to 2 in $(2 * \left(\sqrt{N}\right)^2)$.
In this case, $n = 2i - \underline{v; P; (2)/(1)}$, with $v = P + 1 = 3$.
$n = 2i - \underline{v; P; (2)/(1)} = 2i - 1$ this indicates that the period is odd.
The same applies on the value of i which takes the value of $\sqrt{N}$ (the last number which represents the number of electrons in the last (bracket) line).
$n = 2i - \underline{v; P; (2)/(1)} = 2i - 1 = 2i - 1 = 2\sqrt{N} - 1$

Briefly, To find the value of P, always look at the (*Superior sum*), the following cases will appear:

-If $2*2^2 + 2*3^2 + 2*4^2 + \cdots + 2*\left(\sqrt{\frac{N-1}{2}}\right)^2 + 1*\left(\sqrt{N}\right)^2 \geq \frac{Z-2}{2}$

Therefore, $P = 1 \Rightarrow Period\ is\ even$

-If the $2*2^2 + 2*3^2 + 2*4^2 + \cdots + 2*\left(\sqrt{\frac{N-1}{2}}\right)^2 + 2*\left(\sqrt{N}\right)^2 \geq \frac{Z-2}{2}$

Therefore, $P = 2 \Rightarrow Period\ is\ Odd$

IV.3. Calculation of the peripheral number of electrons

If the atomic number (Z) is given, therefore the equation (5) is used; therefore the Number of peripheral electrons named N_{pe} is equal to $N_{pe} = Z - (2 + 2\sum_{i=2}^{\sqrt{N}} i^2(P))$

In order to find the number N and P mentioned, we have to follow the equations 13, 14, 15 and 16 which lead to the following cases:

• First case:

$$\sum_{i=2}^{\sqrt{N}} i^2(P) == \begin{cases} 2*2^2 + 2*3^2 + 2*4^2 + 2*5^2 + \cdots + 2*\left(\sqrt{\frac{N-1}{2}}\right)^2 < \frac{Z-2}{2} \\ \\ 2*2^2 + 2*3^2 + 2*4^2 + 2*5^2 + \cdots + 2*\left(\sqrt{\frac{N-1}{2}}\right)^2 + 1*\left(\sqrt{N}\right)^2 > \frac{Z-2}{2} \end{cases} \quad (13)$$

$\Rightarrow N_{pe} = Z - (2 + 2\sum_{i=2}^{\sqrt{N}} i^2(P))$

With $\sum_{i=2}^{\sqrt{N}} i^2(P) = 2*2^2 + 2*3^2 + 2*4^2 + 2*5^2 + \cdots + 2*\left(\sqrt{\frac{N-1}{2}}\right)^2$

Which is the lowest summation.

$\Rightarrow N_{pe} = Z - (2 + 2(2*2^2 + 2*3^2 + 2*4^2 + 2*5^2 + \cdots + 2*\left(\sqrt{\frac{N-1}{2}}\right)^2))$ (17)

• Second case:

$$\sum_{i=2}^{\sqrt{N}} i^2(P) == \begin{cases} 2*2^2 + 2*3^2 + 2*4^2 + 2*5^2 + \cdots + 1*\left(\sqrt{N}\right)^2 < \frac{Z-2}{2} \\ 2*2^2 + 2*3^2 + 2*4^2 + 2*5^2 + \cdots + 2*\left(\sqrt{N}\right)^2 > \frac{Z-2}{2} \end{cases} \quad (14)$$

$\Rightarrow N_{pe} = Z - (2 + 2\sum_{i=2}^{\sqrt{N}} i^2(P))$

With $\sum_{i=2}^{\sqrt{N}} i^2(P) = 2*2^2 + 2*3^2 + 2*4^2 + 2*5^2 + \cdots + 1*\left(\sqrt{N}\right)^2$

$\Rightarrow N_{pe} = Z - (2 + 2(2*2^2 + 2*3^2 + 2*4^2 + 2*5^2 + \cdots + 1*\left(\sqrt{N}\right)^2))$ (18)

• Third case:

$$\sum_{i=2}^{\sqrt{N}} i^2(P) == \left\{ 2*2^2 + 2*3^2 + 2*4^2 + 2*5^2 + \cdots + 2*\left(\sqrt{\frac{N-1}{2}}\right)^2 + 1*\left(\sqrt{N}\right)^2 = \frac{Z-2}{2} \right. \quad (15)$$

$\Rightarrow N_{pe} = Z - (2 + 2\sum_{i=2}^{\sqrt{N}} i^2(P))$

With $\sum_{i=2}^{\sqrt{N}} i^2(P) = 2*2^2 + 2*3^2 + 2*4^2 + 2*5^2 + \cdots + 2*\left(\sqrt{\frac{N-1}{2}}\right)^2$ which is the internal line

$\Rightarrow N_{pe} = Z - (2 + 2(2*2^2 + 2*3^2 + 2*4^2 + 2*5^2 + \cdots + 2*\left(\sqrt{\frac{N-1}{2}}\right)^2))$ (19)

• Fourth case:

$$\sum_{i=2}^{\sqrt{N}} i^2(P) == \left\{ 2*2^2 + 2*3^2 + 2*4^2 + 2*5^2 + \cdots + 2*\left(\sqrt{\frac{N-1}{2}}\right)^2 + 2*\left(\sqrt{N}\right)^2 = \frac{Z-2}{2} \right. \quad (16)$$

$\Rightarrow N_{pe} = Z - (2 + 2\sum_{i=2}^{\sqrt{N}} i^2(P))$

With $\sum_{i=2}^{\sqrt{N}} i^2(P) = 2*2^2 + 2*3^2 + 2*4^2 + 2*5^2 + \cdots + 2*\left(\sqrt{\frac{N-1}{2}}\right)^2 + 1*\left(\sqrt{N}\right)^2$

$\Rightarrow N_{pe} = Z - (2 + 2(2*2^2 + 2*3^2 + 2*4^2 + 2*5^2 + \cdots + 2*\left(\sqrt{\frac{N-1}{2}}\right)^2 + 1*\left(\sqrt{N}\right)^2))$ (20)

Briefly, the Number of peripheral electrons (N_{pe}) is equal to $N_{pe} = Z - (2 + 2\sum_{i=2}^{\sqrt{N}} i^2(P))$ where $\sum_{i=2}^{\sqrt{N}} i^2(P)$ is the internal sum of the inferior line.

IV.4. Construction of the ground state electron configuration
　　　　When the period *n* and the number of the peripheral electrons are known, one can construct the ground state electron configuration of the last peripheral line using equation (3).

$$
nS^2 \left[\begin{array}{c} \xrightarrow{2} \\[2em] \left[\begin{array}{c} \xrightarrow{n} \\[1em] jA_i^{4i-2} \\[2em] {}_{j=\frac{n+n;P;(2)/(3)}{2}} \end{array} \right. \\[3em] {}_{i=\frac{n+n;P;(2)/(1)}{2}} \end{array} \right.
$$

To fill the orbital with electron configuration you have to complete the expression in the above formula (jA_i^{4i-2})

Example 1: if the period is *n*=4, and you have 8 peripheral electrons, your final configuration will be as the following: $4S^2 3D^6$

Example 2: if the period is *n*=8, and you have 47 peripheral electrons, your final configuration will be as the following*:* $8S^2 5G^{18} 6F^{14} 7D^{10} 8P^3$

V.　　　Application Examples Of The Theory

　　　　This section is very important to understand the theory and its application in the chemistry domain. In this section, six examples are treated to cover all theories and cases.
　　　　Find the period, group, number of electron configuration and the electron configuration of the last line (ground state electron configuration) for the following atomic numbers: 47, 168, 203, 218, 365, and 10452.

V.1. For Z=47
Step 1:
By equation (6), we have to verify the equality

$$
\sum_{i=2}^{\sqrt{N}} i^2(P) == \frac{Z-2}{2} = \frac{47-2}{2} = 22.5
$$

Step 2:
We have to know exactly which the case applies to the atom amongst one of the equations 13, 14, 15 or 16.

$$
\sum_{i=2}^{\sqrt{N}} i^2(P) == \begin{cases} 2*2^2 + 1*3^2 = 17 < \dfrac{Z-2}{2} = 22.5 \\[1em] 2*2^2 + 2*3^2 = 26 > \dfrac{Z-2}{2} = 22.5 \end{cases}
$$

　　　　In this case we can deduce that *P* is equal to 2 therefore $v = P + 1 = 3$ and $n = 2i - v; P; (2)/(1)$

$\Rightarrow n = 2*3 - 1 = 5$, which is the period of the atom; therefore the period is odd.

Step 3:
Calculation of the number of peripheral electrons:

$$
N_{pe} = Z - \left(2 + 2\sum_{i=2}^{\sqrt{N}} i^2(P) \right) = 47 - \left(2 + 2\left(\sum_{i=2}^{\sqrt{N}} i^2(1) \right) \right) = 47 - (2 + 2(2.2^2 + 1.3^2)) = 11
$$

Therefore the number of peripheral electrons is equal to $N_{pe} = 11$.

Step 4:
　　　　The final step is to write the electron configuration of the last line (ground state electron configuration). As the number of peripheral electron is given, the same for the period, one can find easily the electron configuration.

$$nS^2 \left[\begin{array}{c} \xrightarrow{n} \\ jA_i^{4i-2} \\ j=\frac{n+n;P;(2)/(3)}{2} \end{array} \right]_{i=\frac{n+n;P;(2)/(1)}{2}}^{\to 2} = nS^2 \left[\begin{array}{c} \xrightarrow{n} \\ jA_i^{4i-2} \\ j=\frac{n+3}{2} \end{array} \right]_{i=\frac{n+1}{2}}^{\to 2} = 5S^2 \left[\begin{array}{c} \xrightarrow{5} \\ jA_i^{4i-2} \\ j=4 \end{array} \right]_{i=3}^{\to 2} = 5S^2 4A_3^9 = 5S^2 4D^9 \text{ with } n = 5$$

Briefly the Atom with $Z=47$ has the following characteristic
- Period $n=5$
- Number of peripheral electrons $N_{pe} = 11$
- Group is $D^9 = A_3^9$

V.2. For Z=168
Step 1:
By equation (6), we have to verify the equality
$$\sum_{i=2}^{\sqrt{N}} i^2(P) == \frac{Z-2}{2} = \frac{168-2}{2} = 83$$

Step 2:
We have to know exactly which the case applies to the atom, amongst one of the equations 13, 14, 15 or 16.
$$\sum_{i=2}^{\sqrt{N}} i^2(P) == \left\{ 2.2^2 + 2.3^2 + 2.4^2 + 1.5^2 = 83 = \frac{Z-2}{2} = 83 \right.$$

In this case we can deduce that P is equal to 1 therefore $v = P + 1 = 2$ and $n = 2i - \underline{v; P; (2)/(1)} \Rightarrow n = 2 * 5 - 2 = 8$, which is the period of the atom; therefore the period is even.

Step 3:
Calculation of the number of peripheral electrons will be as the following;
$$N_{pe} = Z - \left(2 + 2\sum_{i=2}^{4} i^2(P) \right) = 168 - \left(2 + 2\left(\sum_{i=2}^{4} i^2(2) \right) \right)$$
$$= 168 - (2 + 2(2 * 2^2 + 2 * 3^2 + 2 * 4^2) = 50$$

Therefore the number of peripheral electrons is equal to $N_{pe} = 50$.

Step 4:
The final step is to write the electron configuration of the last line (ground state electron configuration). As the number of peripheral electron is given, the same for the period, one can find easily the electron configuration.

$$nS^2 \left[\begin{array}{c} \xrightarrow{2} \\ \left[\begin{array}{c} \xrightarrow{n} \\ jA_i^{4i-2} \\ {}_{j=\frac{n+n;P;(2)/(3)}{2}} \end{array} \right] \\ {}_{i=\frac{n+n;P;(2)/(1)}{2}} \end{array} \right] = nS^2 \left[\begin{array}{c} \xrightarrow{2} \\ \left[\begin{array}{c} \xrightarrow{n} \\ jA_i^{4i-2} \\ {}_{j=\frac{n+2}{2}} \end{array} \right] \\ {}_{i=\frac{n+2}{2}} \end{array} \right] = 8S^2 \left[\begin{array}{c} \xrightarrow{2} \\ \left[\begin{array}{c} \xrightarrow{8} \\ jA_i^{4i-2} \\ {}_{j=5} \end{array} \right] \\ {}_{i=5} \end{array} \right] = 8S^2 5A_5^{18} 6A_4^{14} 7A_3^{10} 8A_2^6 \text{ with } n=8$$

Briefly the Atom with $Z=168$ has the following characteristic
- o   Period $n=8$
- o   Number of peripheral electrons $N_{pe} = 50$
- o   Group is A_2^6 (it's location is presented on the picture below)

Fig. 2: The Atom with Z=168 is presented in the circle, it is in the period 8 and group P^6 or A_2^6 of the Bayeh's theoretical periodic table of elements.

V.3. For Z=203
Step 1:
By equation (6), we have to verify the equality.

$$\sum_{i=2}^{\sqrt{N}} i^2(P) == \frac{Z-2}{2} = \frac{203-2}{2} = 100.5$$

Step 2:
We have to know exactly which case applies to the atom amongst one of the equations 13, 14, 15 or 16.

$$\sum_{i=2}^{\sqrt{N}} i^2(P) == \begin{cases} 2*2^2 + 2*3^2 + 2*4^2 + 1*5^2 = 83 < \dfrac{Z-2}{2} = 100.5 \\ \\ 2*2^2 + 2*3^2 + 2*4^2 + 2*5^2 = 108 > \dfrac{Z-2}{2} = 100.5 \end{cases}$$

In this case we can deduce that P is equal to 2 therefore $v = P+1 = 3$ and $n = 2i - v; P;(2)/(1) \Rightarrow n = 2*5 - 1 = 9$ which is the period of the atom; therefore the period is odd.

Step 3:
Calculation of the number of peripheral electrons will be as the following:

$$N_{pe} = Z - \left(2 + 2\sum_{i=2}^{\sqrt{N}} i^2(P)\right) = 203 - \left(2 + 2\left(\sum_{i=2}^{5} i^2(P)\right)\right)$$
$$= 203 - (2 + 2(2*2^2 + 2*3^2 + 2*4^2 + 1*5^2)) = 35$$

Therefore the number of peripheral electrons is equal to $N_{pe} = 35$.

Step 4:
The final step is to write the electron configuration of the last line (ground state electron configuration). As the number of peripheral electron is given, the same for the period, one can find easily the electron configuration.

$$nS^2\left[\begin{array}{c}\xrightarrow{\to 2}\\[4pt]\left[\begin{array}{c}\xrightarrow{\to n}\\[4pt]jA_i^{4i-2}\\[4pt]{}_{j=\frac{n+n;P;(2)/(3)}{2}}\end{array}\right]\\[4pt]{}_{i=\frac{n+n;P;(2)/(1)}{2}}\end{array}\right] = nS^2\left[\begin{array}{c}\xrightarrow{\to 2}\\[4pt]\left[\begin{array}{c}\xrightarrow{\to n}\\[4pt]jA_i^{4i-2}\\[4pt]{}_{j=\frac{n+3}{2}}\end{array}\right]\\[4pt]{}_{i=\frac{n+1}{2}}\end{array}\right] = 9S^2\left[\begin{array}{c}\xrightarrow{\to 2}\\[4pt]\left[\begin{array}{c}\xrightarrow{\to 9}\\[4pt]jA_i^{4i-2}\\[4pt]{}_{j=6}\end{array}\right]\\[4pt]{}_{i=5}\end{array}\right] = 9S^2 6A_5^{18} 7A_4^{14} 8A_3^1 \text{ with } n=9$$

Briefly the Atom with Z=203 has the following characteristic:
- Period n=9
- Number of peripheral electrons $N_{pe} = 35$
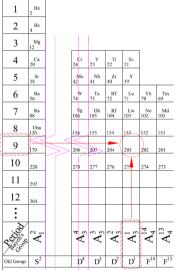- Group is $D^9 = A_3^1$ (it's location is presented on the picture below)

Figure 3: The Atom with Z=203 is presented in the circle, it is in the period 8 and group D^1 or A_3^1 of the Bayeh's theoretical periodic table of elements.

V.4. For Z=218
Step 1:
By equation (6), we have to verify the equality

$$\sum_{i=2}^{\sqrt{N}} i^2(P) == \frac{Z-2}{2} = \frac{218-2}{2} = 108$$

Step 2:

We have to know exactly which case applies to the atom amongst one of the equations 13, 14, 15 or 16.

$$\sum_{i=2}^{\sqrt{N}} i^2(P) == \left\{ 2*2^2 + 2*3^2 + 2*4^2 + 2*5^2 = 108 = \frac{Z-2}{2} = 108 \right.$$

In this case we can deduce that P is equal to 2 therefore $v = P + 1 = 3$ and $n = 2i - v; P; (2)/(1) \Rightarrow n = 2*5 - 1 = 9$ which is the period of the atom, therefore the period is odd.

Step 3:
Calculation of the number of peripheral electrons will be as the following;

$$N_{pe} = Z - \left(2 + 2\sum_{i=2}^{4} i^2(P) \right) = 218 - \left(2 + 2\left(\sum_{i=2}^{4} i^2(P)\right)\right)$$
$$= 218 - (2 + 2(2*2^2 + 2*3^2 + 2*4^2 + 1*5^2)) = 50$$

Therefore the number of peripheral electrons is equal to $N_{pe} = 50$.

Step 4:
   The final step is to write the electron configuration of the last line (ground state electron configuration). As the number of peripheral electron is given, the same for the period, one can find easily the electron configuration.

$$nS^2\left[\begin{array}{c}\xrightarrow{2}\\ \left[\begin{array}{c}\xrightarrow{n}\\ jA_i^{4i-2}\\ j=\frac{n+n;P;(2)/(3)}{2}\end{array}\right]\\ i=\frac{n+n;P;(2)/(1)}{2}\end{array}\right] = nS^2\left[\begin{array}{c}\xrightarrow{2}\\ \left[\begin{array}{c}\xrightarrow{n}\\ jA_i^{4i-2}=9S^2\\ j=\frac{n+3}{2}\end{array}\right]\\ i=\frac{n+1}{2}\end{array}\right]\left[\begin{array}{c}\xrightarrow{2}\\ \left[\begin{array}{c}\xrightarrow{9}\\ jA_i^{4i-2}=9S^2\,6A_5^{18}7A_4^{14}8A_3^{10}9A_2^6\\ j=6\end{array}\right]\\ i=5\end{array}\right]\text{ with } n=9$$

Briefly the Atom with $Z=218$ has the following characteristic
- o Period $n=9$
- o Number of peripheral electrons $N_{pe} = 50$
- o Group is A_2^6

V.5. For Z=365

Step 1:
By equation (6), we have to verify the equality

$$\sum_{i=2}^{\sqrt{N}} i^2(P) == \frac{Z-2}{2} = \frac{365-2}{2} = 181.5$$

Step 2:
We have to know exactly which case applies to the atom amongst one of the equations 13, 14, 15 or 16.

$$\sum_{i=2}^{\sqrt{N}} i^2(P) == \left\{ \begin{array}{l} 2*2^2 + 2*3^2 + 2*4^2 + 2*5^2 + 2*6^2 = 180 \; < \frac{Z-2}{2} = 181.5 \\ 2*2^2 + 2*3^2 + 2*4^2 + 2*5^2 + 2*6^2 + 1*7^2 = 229 > \frac{Z-2}{2} = 181.5 \end{array} \right.$$

In this case we can deduce that P is equal to 1 therefore $v = P + 1 = 2$ and $n = 2i - v; P; (2)/(1) \Rightarrow n = 2*7 - 2 = 12$ which is the period of the atom, therefore the period is even.

Step 3:

Calculation of the number of peripheral electrons will be as the following;

$$N_{pe} = Z - \left(2 + 2\sum_{i=2}^{\sqrt{N}} i^2(P)\right) = 365 - \left(2 + 2\left(\sum_{i=2}^{6} i^2(P)\right)\right)$$
$$= 365 - (2 + 2(2*2^2 + 2*3^2 + 2*4^2 + 2*5^2 + 2*6^2)) = 3$$

Therefore the number of peripheral electrons is equal to $N_{pe} = 3$.

Step 4:

The final step is to write the electron configuration of the last line (ground state electron configuration). As the number of peripheral electron is given, the same for the period, one can find easily the electron configuration.

$$nS^2 \begin{bmatrix} \overset{\to 2}{} \\ \begin{bmatrix} \overset{\to n}{} \\ jA_i^{4i-2} \\ {}_{j=\frac{n+n;P;(2)/(3)}{2}} \end{bmatrix}_{i=\frac{n+n;P;(2)/(1)}{2}} \end{bmatrix} = nS^2 \begin{bmatrix} \overset{\to 2}{} \\ \begin{bmatrix} \overset{\to n}{} \\ jA_i^{4i-2} \\ {}_{j=\frac{n+2}{2}} \end{bmatrix}_{i=\frac{n+2}{2}} \end{bmatrix} = 12S^2 \begin{bmatrix} \overset{\to 2}{} \\ \begin{bmatrix} \overset{\to 12}{} \\ jA_i^{4i-2} \\ {}_{j=7} \end{bmatrix}_{i=7} \end{bmatrix} = 12S^2 7A_7^1 \text{ with } n = 12$$

Briefly the Atom with Z=203 has the following characteristic
  o   Period $n=12$
  o   Number of peripheral electrons $N_{pe} = 3$
  o   Group is A_7^1

V.6. For Z=10452
Step 1:
By equation (6), we have to verify the equality

$$\sum_{i=2}^{\sqrt{N}} i^2(P) == \frac{Z-2}{2} = \frac{10452-2}{2} = 5225$$

Step 2:
We have to know exactly which case applies to the atom amongst one of the equations 13, 14, 15 or 16.

$$\sum_{i=2}^{\sqrt{N}} i^2(P) == \begin{cases} 2*2^2 + 2*3^2 + 2*4^2 + \cdots + 2*19^2 = 4938 < \frac{Z-2}{2} = 5225 \\ 2*2^2 + 2*3^2 + 2*4^2 + \cdots + 2*19^2 + 1*20^2 = 5338 > \frac{Z-2}{2} = 5225 \end{cases}$$

In this case we can deduce that P is equal to 1 therefore $v = P + 1 = 2$ and $n = 2i - v; P; (2)/(1) \Rightarrow n = 2 * 20 - 2 = 38$ which is the period of the atom, therefore the period is even.

Step 3:
Calculation of the number of peripheral electrons will be as the following:

$$N_{pe} = Z - \left(2 + 2\sum_{i=2}^{\sqrt{N}} i^2(P)\right) = 10452 - \left(2 + 2\left(\sum_{i=2}^{19} i^2(P)\right)\right)$$
$$= 365 - (2 + 2(2*2^2 + 2*3^2 + 2*4^2 + 2*5^2 + \cdots + 2*19^2)) = 574$$

Therefore the number of peripheral electrons is equal to $N_{pe} = 574$.

Step 4:

The final step is to write the electron configuration of the last line (ground state electron configuration). As the number of peripheral electron is given, the same for the period, one can find easily the electron configuration.

$$nS^2\left[\begin{array}{c}\rightarrow 2 \\ \\ \left[\begin{array}{c}\rightarrow n \\ \\ jA_i^{4i-2} \\ \\ j=\frac{n+n;P;(2)/(3)}{2}\end{array}\right. \\ \\ i=\frac{n+n;P;(2)/(1)}{2}\end{array}\right. = nS^2\left[\begin{array}{c}\rightarrow 2 \\ \\ \left[\begin{array}{c}\rightarrow n \\ \\ jA_i^{4i-2} \\ \\ j=\frac{n+2}{2}\end{array}\right. \\ \\ i=\frac{n+2}{2}\end{array}\right. =$$

$$38S^2\left[\begin{array}{c}\rightarrow 2 \\ \\ \left[\begin{array}{c}\rightarrow 38 \\ \\ jA_i^{4i-2} \\ \\ j=20\end{array}\right. \\ \\ i=20\end{array}\right. = 38S^2\,20A_{20}^{78}\,21A_{19}^{74}\,22A_{18}^{70}\,23A_{17}^{66}\,24A_{16}^{62}\,25A_{15}^{58}\,26A_{14}^{54}\,27A_{13}^{50}\,28A_{12}^{46}\,29A_{11}^{14}$$

with $n = 38$

Briefly the Atom with Z=10452 has the following characteristic
- o Period n=38
- o Number of peripheral electrons $N_{pe} = 574$
- o Group is A_{11}^{14}

VI. Programming In C++ Language
These formulae can be simply programmed. The following program is written in C++ in order to facilitate the manipulation of the formulae introduced by the author and to visualize the results by a simple click. The user will obtain immediately results by just introducing the number *Z* of the atom.

- -

```
#include<cmath>
#include<iostream>
using namespace std;
int z=0;  double d=0.0;   int p=1;  int n=2;  int t=0;  int no;   int i=0;   int j=0;  double somme=0.0; double som=0.0;

int main ()
{cout<<" General Theory of electronic configuration of atoms, By Claude Ziad Bayeh in 2004/02/08"<<" Programmed by Claude Ziad Bayeh "<<endl;  cout<<endl;
  cout<<" General theory of electron configuration"<<endl<<" of the ground state electron configuration"<<
        endl<<" The period and the number of electron for the peripheral line"<<endl<<"---------------------------
---------------"<<endl;
 cout<<"Give the Atomic Number:  "<<endl;
 cin>>z;
  while(z>=0)
  {switch(z)
        {case 0:cout<<"0s(0)"<<endl;break;
         case 1:cout<<"1s(1)"<<endl;break;
         case 2:cout<<"1s(2)"<<endl;break;
          default:p=1;
        n=2;  somme=0.0;  som=0.0;   d=(((static_cast<double>(z))-2)/2);    somme+=p*pow(n,2);
     for(int k=0;;) {   if(somme<d) {  if(p==1){p++;som+=p*pow(n,2);somme=som;}
```

```
                    else {p--;n++;somme+=p*pow(n,2);};
                }
                   else break;
                };
        if(p==1){t=2*(n-1);no=z-(2+2*(static_cast<int>(somme-pow(n,2))));}
        else {t=2*n-1;no=z-(2+2*(static_cast<int>(somme-pow(n,2))));};
        cout<<"periode: "<<t<<endl<<"electrons peripheriques: "<<no<<endl;
        cout<<"configuration electronique de la derniere couche peripherique:"<<endl<<t<<"s("<<flush;

        if(2<no) {cout<<2<<") "<<flush;no-=2;}   else {cout<<no<<") "<<flush;no=0;}  ;
        if((t%2)==0) {i=(t+2)/2;j=i;}    else {i=(t+1)/2;j=(t+3)/2;};

        while(no!=0){
                switch(i)
                    {case 2:cout<<j<<"p"<<"("<<flush;
                        if((4*i-2)<no) {cout<<4*i-2<<") "<<flush;no-=4*i-2;}
                        else {cout<<no<<") "<<flush;no=0;} ; break;
                     case 3:cout<<j<<"d"<<"("<<flush;
                        if((4*i-2)<no) {cout<<4*i-2<<") "<<flush;no-=4*i-2;}
                        else {cout<<no<<") "<<flush;no=0;} ; break;
                     case 4:cout<<j<<"f"<<"("<<flush;
                        if((4*i-2)<no) {cout<<4*i-2<<") "<<flush;no-=4*i-2;}
                        else {cout<<no<<") "<<flush;no=0;} ; break;

                     default:cout<<j<<"{A"<<i<<"}"<<"("<<flush;
                        if((4*i-2)<no) {cout<<4*i-2<<") "<<flush;no-=4*i-2;}
                        else {cout<<no<<") "<<flush;no=0;} ; break;
                    };
                j++;
                i--;
                };

        cout<<endl<<endl;break;
        };
    cout<<"Give another Atomic number or write a negative number to end program"<<endl;
    cin>>z;
 }
 return 0;
}
```

- -

VII.   PROGRAMMING IN Visual Basic.NET

The formulae can be simply programmed using language Visual Basic.NET. The following program is written in VB.NET in order to simulate the result.

Note: The following script is a part of the complete program, because the other parts are programmed visually using special configurations which can't be written in total. In order to obtain the software, please contact the author.

- -

```
'In the function we put :
    Dim z As Integer = 0
    Dim d As Double = 0.0
    Dim p As Integer = 1
    Dim n As Integer = 2
    Dim t As Integer = 0
    Dim no As Integer
    Dim i As Integer = 0
    Dim j As Integer = 0
    Dim somme As Double = 0.0
    Dim som As Double = 0.0
```

```
        Dim a As Integer = 1
        Dim output As String

        z = TextBox1.Text

    Select Case z
        Case 0
            MessageBox.Show("0s(0)", " Ground state electron configuration (Configuration electronique de la
derniere couche)",MessageBoxButtons.OK)
        Case 1
            MessageBox.Show("1s(1)", " Ground state electron configuration (Configuration electronique de la
derniere couche)",MessageBoxButtons.OK)
        Case 2
            MessageBox.Show("1s(2)", " Ground state electron configuration (Configuration electronique de la
derniere couche)", MessageBoxButtons.OK)
        Case Else
            p = 1
            n = 2
            somme = 0.0
            som = 0.0
            d = (((Convert.ToDouble(z)) - 2) / 2)
            somme += p * Math.Pow(n, 2)
            While a = 1
                If somme < d Then

                    If p = 1 Then
                        p = p + 1
                        som += p * Math.Pow(n, 2)
                        somme = som
                    Else
                        p = p - 1
                        n = n + 1
                        somme += p * Math.Pow(n, 2)
                    End If

                Else
                    Exit While
                End If
            End While

            If p = 1 Then
                t = 2 * (n - 1)
                no = z - (2 + 2 * (Convert.ToInt32(somme - Math.Pow(n, 2))))
            Else
                t = 2 * n - 1
                no = z - (2 + 2 * (Convert.ToInt32(somme - Math.Pow(n, 2))))
            End If
            output = "periode: " & t & vbCrLf & "Peripheral electron (electrons peripheriques): " & no & vbCrLf
            output &= " Ground state electron configuration (configuration electronique de la derniere couche
peripherique):" & vbCrLf & t & "s("

            If 2 < no Then
                output &= 2 & ") "
                no -= 2
            Else
                output &= no & ") "
                no = 0
            End If
```

```
If (t Mod (2)) = 0 Then
    i = (t + 2) / 2
    j = i
Else
    i = (t + 1) / 2
    j = (t + 3) / 2
End If

While (no <> 0)
    Select Case i
        Case 2
            output &= j & "p" & "("
            If (4 * i - 2) < no Then
                output &= (4 * i - 2) & ")  "
                no -= 4 * i - 2
            Else
                output &= no & ")  "
                no = 0
            End If
        Case 3
            output &= j & "d" & "("
            If (4 * i - 2) < no Then
                output &= (4 * i - 2) & ")  "
                no -= 4 * i - 2
            Else
                output &= no & ")  "
                no = 0
            End If
        Case 4
            output &= j & "f" & "("
            If (4 * i - 2) < no Then
                output &= (4 * i - 2) & ")  "
                no -= 4 * i - 2
            Else
                output &= no & ")  "
                no = 0
            End If

        Case Else
            output &= j & "{A" & i & "}" & "("
            If (4 * i - 2) < no Then
                output &= (4 * i - 2) & ")  "
                no -= 4 * i - 2
            Else
                output &= no & ")  "
                no = 0
            End If
    End Select
    j = j + 1
    i = i - 1
End While
output &= vbCrLf & vbCrLf
MessageBox.Show(output, " Ground state electron configuration (Configuration electronique de la
derniere couche)", MessageBoxButtons.OK)
End Select
                            - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
```

VII.1. Bayeh's Periodic table of Elements
      The following table is designed with VB.Net by the author and it can be considered the application of the theory on a periodic table. (This software is copyrighted, if you wish to order it, you must purchase it from the author directly).

Fig. 4: represents a part of the Bayeh's theoretical periodic table of elements.

VII.2. Results obtained using the software
      Note: The original software is written by the author in French language, so check the translation below the pictures for further understanding.
      •If one pushes the button of an element, a window will appear and describe the element's characteristics, as the name of the atom, the Atomic number, the atomic mass….
For example if one pushes the Fluor box, the following window appears

Fig. 5: The window that appears by pressing on the element

      • There is a box that one can write the Atomic number and by clicking on the OK icon, results will appear as the following

Fig. 5.1: Introducing the atomic number Z to the software.

Write the Atomic number 287 for example

Fig. 5.2: Introducing the atomic number Z to the software.

The following results will appear

Fig. 6.1: represents the period, number of peripheral electrons, and electron configuration of an atom
In this case, the period, the Peripheral number of electrons and the electronic configuration will appear.

• Example for Z=47

Configuration electronique de la derniere couche

periode: 5
electrons peripheriques: 11
configuration electronique de la derniere couche peripherique:
5s(2) 4d(9)
Erreur de la configuration:
5s(1) 4d(10)

OK

Fig. 6.2: represents the period, number of peripheral electrons, and electron configuration of an atom

• Example for Z=5420

Configuration electronique de la derniere couche

periode: 30
electrons peripheriques: 462
configuration electronique de la derniere couche peripherique:
30s(2) 16{A16}(62) 17{A15}(58) 18{A14}(54) 19{A13}(50) 20{A12}(46) 21{A11}(42) 22{A10}(38) 23{A9}(34) 24{A8}(30) 25{A7}(26) 26{A6}(20)

OK

Fig. 6.3: represents the period, number of peripheral electrons, and electron configuration of an atom

• Example for Z= nm32

Attention

ERROR enter a valid number

OK

Fig. 7: Error window appears in case of a false data entry.

In this case as the data is not in integer form, so the program opens a window telling the error.

• The software is developed in a way that if one writes letters in the middle or at the end (Z= 321nmrfr2) the software will consider only the first digits as an input.
• If the entered number is decimal, then the program will consider the closest integer to the number:
E.g.: if Z=34.4566 is entered, the program takes Z=34,
     If Z=34.5566 is entered, the program takes Z=35.
• One can know the group of the element from the ground state electron configuration (the last line electron configuration), it is based on the theoretical study and not on the practical study of the atom; for in the latter case, many errors are obtained naturally.
       For example the atom with Z=47 shown below, has two ground state configuration for the last line, the first configuration is obtained by theory as the study in this paper, while the second one represents the configuration error that is encountered by natural experience, in which is called error of the configuration. The theoretical configuration that appears is ($55S^2\ 4D^9$), though in reality, this atom has errors in which the electron configuration is ($55S^1\ 4D^{10}$). (refer to figure 6)

Configuration electronique de la derniere couche

periode: 5
electrons peripheriques: 11
configuration electronique de la derniere couche peripherique:
5s(2) 4d(9)
Erreur de la configuration:
5s(1) 4d(10)

OK

Fig. 8: Representing two electron configurations of the Atomic number 47: the theoretical configuration and the actual configuration.

VIII. Formulation Of The Theoretical Periodic Table

The treated theory above can be applied by illustrating a theoretical periodic table that gives the theoretical positioning of the atom according the quantum physics, and then by applying the theory that is developed by the author. For a given Atomic number, the period and the electron configuration are known; therefore, one can know the exact location of the elements in the periodic table.

For example, by calculating the atomic number for Z=47, the obtained period is 5 and the configuration of the electron's last orbital is: $4D^9$. Therefore, by locating the correct period (5), and the matching group ($4D^9$), the correct atom will be found on the following Theoretical Periodic Table.
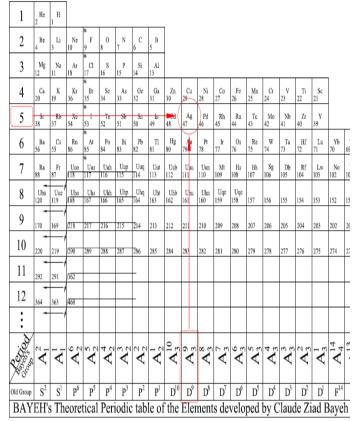

Fig. 9.1: Finding the position of an element, after having its period and last orbital's configuration.
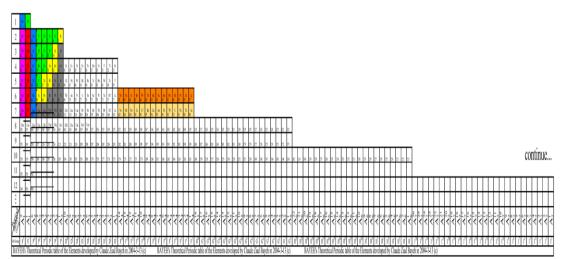

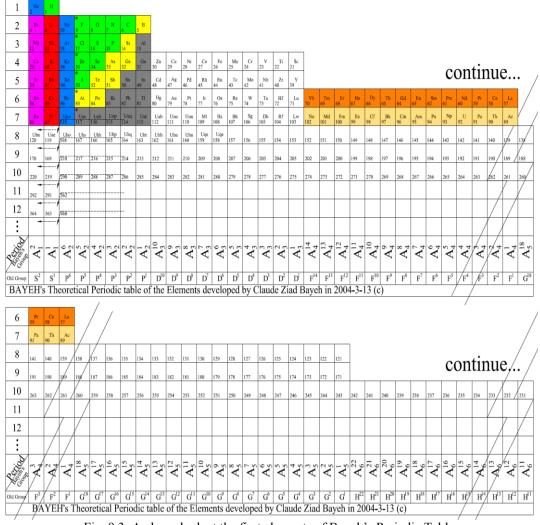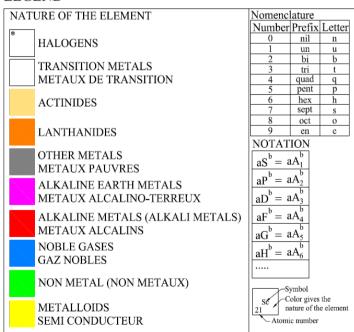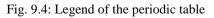Fig. 9.2: Extracted part of the Bayeh's periodic table.

BAYEH's Theoretical Periodic table of the Elements developed by Claude Ziad Bayeh in 2004-3-13 (c)

BAYEH's Theoretical Periodic table of the Elements developed by Claude Ziad Bayeh in 2004-3-13 (c)

Fig. 9.3: A closer look at the first elements of Bayeh's Periodic Table.

LEGEND

NATURE OF THE ELEMENT

| * | HALOGENS |
| TRANSITION METALS METAUX DE TRANSITION |
| ACTINIDES |
| LANTHANIDES |
| OTHER METALS METAUX PAUVRES |
| ALKALINE EARTH METALS METAUX ALCALINO-TERREUX |
| ALKALINE METALS (ALKALI METALS) METAUX ALCALINS |
| NOBLE GASES GAZ NOBLES |
| NON METAL (NON METAUX) |
| METALLOIDS SEMI CONDUCTEUR |

Nomenclature

Number	Prefix	Letter
0	nil	n
1	un	u
2	bi	b
3	tri	t
4	quad	q
5	pent	p
6	hex	h
7	sept	s
8	oct	o
9	en	e

NOTATION

$$aS^b = aA_1^b$$
$$aP^b = aA_2^b$$
$$aD^b = aA_3^b$$
$$aF^b = aA_4^b$$
$$aG^b = aA_5^b$$
$$aH^b = aA_6^b$$
.....

Sc 21 — Symbol / Color gives the nature of the element / Atomic number
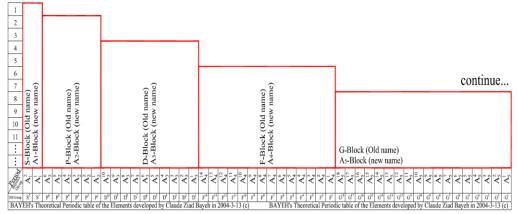
Fig. 9.4: Legend of the periodic table

Fig. 9.5: Theoretical periodic table arranged by sequential Blocks with respective Groups number.

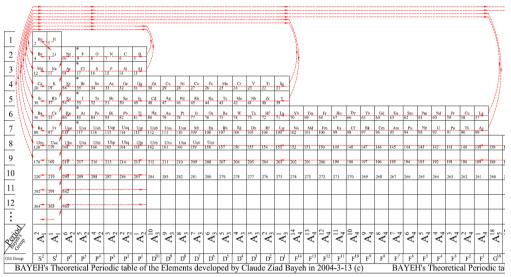
Fig. 9.6: Theoretical periodic table arranged by sequential atomic numbers.

IX.   Conclusion

As we have seen in this paper, the importance of this theory is in facilitating the process of calculation. In fact, this theory can be used to obtain information about the atom (like its ground state electron's configuration, its period, group, number of electron configuration, etc...). And this method can be applied to give precise answers, with a minimum calculation time.

The author has also developed this theory in two different programming languages as C++ and VB.NET, in order to allow the student to copy and simulate it on his own and obtain accurate results.

In addition, and based on the same theory, the author has also developed a new periodic table which it is explained in the articles named "Bayeh's theoretical periodic table" [3]. (It is also presented in chapter 2 in this book).

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