Atomic Energies from Hydrogen to Krypton

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Abstract

In the order of the Deterministic Quantum Model we calculate energies of electrons inside atoms of chemical elements from hydrogen to krypton. Calculation proves argon Ar (Z=18) has in the third level n=3 a configuration (6+2), composed of 6 electrons in the first sub-level s and of 2 electrons in the second sub-level p. This configuration is characterized by high stability and chemical inertia proven by the fact that argon belongs to the group of inert elements. The specific behaviour of argon biases and allows to explain the behaviour of subsequent chemical elements.

1. Introduction

We calculated in "Quantum States and Energy Levels in Hydrogen Atom "[1] discrete levels of energy that are available for the unique electron of hydrogen atom (Z=1) because of an absorption of a discrete quantum of energy that allows electron of jumping from the fundamental state, characterized by quantum numbers n=1, k=1, j=1, s=1/2, to subsequent states defined by different sets of four numbers.
In this article we intend to calculate energy levels that are occupied effectively by electrons of chemical elements with atomic number Z>1.
To that end we make use of the relation of the deterministic quantum model of atom[2][3] :

$$E_{nkjs} = -\frac{2Z^2Rhc}{n^2}\left(1-\frac{k^2}{2n^2}\right)\left(1-\frac{1}{2}\frac{\alpha^2Z^2(j-s)^2}{n^4}\right) \qquad (1)$$

in which

n = 1, 2 , ... quantum number of level
k = 1, 2 ,..... n quantum number of sub-level
j = ±1, ±2, ...±k quantum number of orbital momentum
$s = \left|\frac{j}{2}\right|$ quantum number of spin that is always positive for electron

Energy of the unique electron of hydrogen atom H (Z=1) has been already calculated[1]

$$E_{1s1} = -13.63219\ eV \qquad (2)$$

This energy is ionization energy of hydrogen atom that represents the necessary energy for extracting electron from atom and for ionizing it[4].
For calculation of energies of electrons of chemical elements with Z>1 it needs to consider positive electric charge of nucleus that effectively acts towards electron: in fact under a few physical conditions electron, that has negative charge, is shielded from electrons that are into most internal levels and on this account the effective value of Z for calculation of energy of every electron must consider that shielding effect. We assume that shielding action isn't due to the single electron but to a complete level of electrons or to a particular configuration of electrons, like for instance a stablest configuration of eight electrons.

2. Energy levels of electrons in helium atom He (Z=2)

Helium has two electrons in the level n=1. In that case therefore there isn't a shielding effect and it needs to consider for both electrons the effective value Z=2.
Making use of (1) energy of the first more internal electron is given by the following quantum numbers: n=1, k=1, j=1, s=1/2. Hence

E_{1s1} = - 54.5276757932 eV

The second electron has quantum numbers n=1, k=1, j=-1, s=1/2. Hence its energy is

E_{1s2} = - 54.5160607945 eV

It is possible to observe a smallest difference of energy between the two electrons due to the splitting because of different quantum numbers of orbital momentum. Helium atom presents an unique complete level and consequently it has stablest properties.

3. Energy levels of electrons in lithium atom Li (Z=3)

Litium has atomic number Z=3. It has two electrons in the complete quantum level n=1 and one electron in the level n=2, k=1. The two electrons of the level 1 have energies:

E_{1s1} = - 122.683187137 eV with n=1, k=1, j=1, s=1/2

E_{1s2} = - 122.624386206 eV with n=1, k=1, j=-1, s=1/2

Electron of the second level n=2 is shielded by the two electrons of the first complete level n=1 and hence it is subject to an effective positive charge equal to Z=1 and consequently

E_{2s1} = - 5.96412085731 eV with n=2, k=1, j=1, s=1/2 Z=1

In that case E_{2s1} represents the ionization energy or potential of lithium.

4. Energy levels of electrons in beryllium atom Be (Z=4)

The two electrons in the first level n=1 have energies

E_{1s1} = - 218.093280673 eV with n=1, k=1, j=1, s=1/2, Z=4

E_{1s2} = - 217.907440695 eV with n=1, k=1, j=-1, s=1/2, Z=4

The two electrons in the second level n=2, considering the effective nuclear charge is shielded by the two electrons of the first complete level, have energies

E_{2s1} = - 23.856453655 eV with n=2, k=1, j=1, s=1/2, Z=2

E_{2s2} = - 23.856334456 eV with n=2, k=1, j=2, s=1, Z=2

5. Energy levels of electrons in boron atom B (Z=5)

The two electrons of the first level n=1 have energies

E_{1s1} = - 340.750334064 eV with n=1, k=1, j=1, s=1/2, Z=5

E_{1s2} = - 340.296623179 eV with n=1, k=1, j=-1, s=1/2, Z=5

Three electrons in the second level n=2, considering the effective nuclear charge is shielded by the two electrons of the first complete level, have energies

E_{2s1} = - 53.6769090683 eV with n=2, k=1, j=1, s=1/2, Z=3

E_{2s2} = - 53.6763061288 eV with n=2, k=1, j=2, s=1, Z=3

E_{2s3} = - 53.6753012306 eV with n=2, k=1, j=-1, s=1/2, Z=3

6. Energy levels of electrons in carbon atom C (Z=6)

The two electrons of the first level n=1 have energies

E_{1s1} = - 490.64454715 eV with n=1, k=1, j=1, s=1/2, Z=6

E_{1s2} = - 489.703732259 eV with n=1, k=1, j=-1, s=1/2, Z=6

The four electrons in the second level n=2, considering the effect of shielding by electrons of the first level, have energies

E_{2s1} = - 95.4253382241 eV with n=2, k=1, j=1, s=1/2, Z=4

E_{2s2} = - 95.423432638 eV with n=2, k=1, j=2, s=1, Z=4

E_{2s3} = - 95.4202566623 eV with n=2, k=1, j=-1, s=1/2, Z=4

E_{2s4} = - 95.4031063903 eV with n=2, k=1, j=-2, s=1, Z=4

7. Energy levels of electrons in nitrogen atom N (Z=7)

Energies of electrons of the first level n=1 are

E_{1s1} = - 667.763941969 eV with n=1, k=1, j=1, s=1/2, Z=7

E_{1s2} = - 666.020966233 eV with n=1, k=1, j=-1, s=1/2, Z=7

The four electrons in the second level n=2 and first sub-level k=1, considering shielding by the two electrons of the first level, have energies

E_{2s1} = - 149.101532697 eV with n=2, k=1, j=1, s=1/2, Z=5

E_{2s2} = - 149.096880388 eV with n=2, k=1, j=2, s=1, Z=5

E_{2s3} = - 149.089126541 eV with n=2, k=1, j=-1, s=1/2, Z=5

E_{2s4} = - 149.047255759 eV with n=2, k=1, j=-2, s=1, Z=5

Electron of the second sub-level n=2, k=2 similarly is shielded by electrons of the first level for which it has energy

E_{2p1} = - 85.2008758269 eV with n=2, k=2, j=1, s=1/2 Z=5

8. Energy levels of electrons in oxigen atom O (Z=8)

The two electrons of the first level n=1 have energies

E_{1s1} = - 872.094362727 eV with n=1, k=1, j=1, s=1/2, Z=8

E_{1s2} = - 869.120923073 eV with n=1, k=1, j=-1, s=1/2, Z=8

The four electrons of the second level n=2 and first sub-level k=1, because of the shielding action of the first level, have energies

E_{2s1} = - 214.705224516 eV with n=2, k=1, j=1, s=1/2, Z=6

E_{2s2} = - 214.695577489 eV with n=2, k=1, j=2, s=1, Z=6

E_{2s3} = - 214.67949911 eV with n=2, k=1, j=-1, s=1/2, Z=6

E_{2s4} = - 214.592675861 eV with n=2, k=1, j=-2, s=1, Z=6

The two electrons of the second sublevel have energies

E_{2p1} = - 122.688699723 eV with n=2, k=2, j=1, s=1/2 Z=6

E_{2p2} = - 122.683187137 eV with n=2, k=2, j=2, s=1 Z=6

9. Energy levels of electrons in fluorine atom F (Z=9)

The two electrons of the first level n=1 have energies

E_{1s1} = - 1103.61947585 eV with n=1, k=1, j=1, s=1/2, Z=9

E_{1s2} = - 1098.85660047 eV with n=1, k=1, j=-1, s=1/2, Z=9

Electrons of the first sub-level k=1 of the second level n=2 have energies

E_{2s1} = - 292.236086156 eV with n=2, k=1, j=1, s=1/2, Z=7

E_{2s2} = - 292.218213847eV with n=2, k=1, j=2, s=1, Z=7

E_{2s3} = - 292.188426662 eV with n=2, k=1, j=-1, s=1/2, Z=7

E_{2s4} = - 292.027575875 eV with n=2, k=1, j=-2, s=1, Z=7

The three electrons of the second sub-level k=2 have energies

E_{2p1} = - 166.992049233 eV with n=2, k=2, j=1, s=1/2 Z=7

E_{2p2} = - 166.981836486 eV with n=2, k=2, j=2, s=1 Z=7

E_{2p3} = - 166.964815237 eV with n=2, k=2, j=-1, s=1/2 Z=7

10. Energy levels of electrons in neon atom Ne (Z=10)

The two electrons of the first level n=1 have energies

E_{1s1} = - 1362.21911748 eV with n=1, k=1, j=1, s=1/2, Z=10

E_{1s2} = - 1355.06139577 eV with n=1, k=1, j=-1, s=1/2, Z=10

Energies of electrons of the level n=2 and sub-level k=1 are

E_{2s1} = - 381.693730552 eV with n=2, k=1, j=1, s=1/2, Z=8

E_{2s2} = - 381.663241179 eV with n=2, k=1, j=2, s=1, Z=8

E_{2s3} = - 381.702464485 eV with n=2, k=1, j=-1, s=1/2, Z=8

E_{2s4} = - 381.698176917 eV with n=2, k=1, j=-2, s=1, Z=8

Energies of electrons othe second sub-level k=2 of the level n=2 are

E_{2p1} = - 218.110703172 eV with n=2, k=2, j=1, s=1/2 Z=8

E_{2p2} = - 218.093280673 eV with n=2, k=2, j=2, s=1 Z=8

E_{2p3} = - 218.064243178 eV with n=2, k=2, j=-1, s=1/2 Z=8

E_{2p4} = - 217.907440695 eV with n=2, k=2, j=-2, s=1 Z=8

Neon atom presents two complete levels (n=1 and n=2) and hence it has stablest properties. In fact neon belongs to the group of inert elements.

11. Energy levels of electrons in sodium atom Na (Z=11)

Energies of the first level are

E_{1s1} = - 1648.17755575 eV with n=1, k=1, j=1, s=1/2, Z=11

E_{1s2} = - 1637.54910603 eV with n=1, k=1, j=-1, s=1/2, Z=11

The sublevel k=1 of the level n=2 has energies

E_{2s1} = - 483.077711074 eV with n=2, k=1, j=1, s=1/2, Z=9

E_{2s2} = - 483.028872999 eV with n=2, k=1, j=2, s=1, Z=9

E_{2s3} = - 482.9474762 eV with n=2, k=1, j=-1, s=1/2, Z=9

E_{2s4} = - 482.507933501 eV with n=2, k=1, j=-2, s=1, Z=9

Electrons of the second sub-level k=2 of the second level n=2 have energies

E_{2p1} = - 218.110703172 eV with n=2, k=2, j=1, s=1/2 Z=9

E_{2p2} = - 218.093280673 eV with n=2, k=2, j=2, s=1 Z=9

E_{2p3} = - 218.064243178 eV with n=2, k=2, j=-1, s=1/2 Z=9

E_{2p4} = - 217.907440695 eV with n=2, k=2, j=-2, s=1 Z=9

Because the levels n=1 and n=2 are complete, the last electron of sodium occupies the first quantum state of the level n=3 and because the level n=3 is shielded by the two preceding complete levels, this electron has energy

E_{3s1} = - 2.86109596963 eV with n=3, k=1, j=1, s=1/2 Z=1

12. Energy levels of electrons in magnesium atom Mg (Z=12)

Energies of the first level n=1 are

E_{1s1} = - 1961.16696625 eV with n=1, k=1, j=1, s=1/2, Z=12

E_{1s2} = - 1946.113928 eV with n=1, k=1, j=-1, s=1/2, Z=12

Energies of the second level n=2 and first sub-level k=1 are

E_{2s1} = - 596.38751551 eV with n=2, k=1, j=1, s=1/2, Z=10

E_{2s2} = - 596.313084613 eV with n=2, k=1, j=2, s=1, Z=10

E_{2s3} = - 596.189023039 eV with n=2, k=1, j=-1, s=1/2, Z=10

E_{2s4} = - 595.519090563 eV with n=2, k=1, j=-2, s=1, Z=10

Energies of the second sub-level k=2 of the second level n=2 are

E_{2p1} = - 340.792869459 eV with n=2, k=2, j=1, s=1/2 Z=10

E_{2p2} = - 340.750334064 eV with n=2, k=2, j=2, s=1 Z=10

E_{2p3} = - 340.679441738 eV with n=2, k=2, j=-1, s=1/2 Z=10

E_{2p4} = - 340.296623179 eV with n=2, k=2, j=-2, s=1 Z=10

Electrons of the level n=3 have energies

E_{3s1} = - 11.4443810572 eV with n=3, k=1, j=1, s=1/2 Z=2

E_{3s2} = - 11.4443697715 eV with n=3, k=1, j=2, s=1 Z=2

13. Energy levels of electrons in aluminium atom Al (Z=13)

Electrons of the first level n=1 have energies

E_{1s1} = - 2301.26395666 eV with n=1, k=1, j=1, s=1/2, Z=13

E_{1s2} = - 2280.53045813 eV with n=1, k=1, j=-1, s=1/2, Z=13

The sub-level k=1 of the level n=2 has energies

E_{2s1} = - 721.62259627 eV with n=2, k=1, j=1, s=1/2, Z=11

E_{2s2} = - 721.513613145 eV with n=2, k=1, j=2, s=1, Z=11

E_{2s3} = - 721.331974595 eV with n=2, k=1, j=-1, s=1/2, Z=11

E_{2s4} = - 720.3511264558 eV with n=2, k=1, j=-2, s=1, Z=11

Energies of the sub-level k=2 are

E_{2p1} = - 412.355769296 eV with n=2, k=2, j=1, s=1/2 Z=11

E_{2p2} = - 412.293493226 eV with n=2, k=2, j=2, s=1 Z=11

E_{2p3} = - 412.189692963 eV with n=2, k=2, j=-1, s=1/2 Z=11

E_{2p4} = - 411.629215118 eV with n=2, k=2, j=-2, s=1 Z=11

In the level n=3 electrons have energies

E_{3s1} = - 25.7498467984 eV with n=3, k=1, j=1, s=1/2 Z=3

E_{3s2} = - 25.7497896647 eV with n=3, k=1, j=2, s=1 Z=3

E_{3s3} = - 25.7496944413 eV with n=3, k=1, j=3, s=3/2 Z=3

14. Energy levels of electrons in silicic atom Si (Z=14)

The two electrons of the first level n=1 have energies

E_{1s1} = - 2668.44130426 eV with n=1, k=1, j=1, s=1/2, Z=14

E_{1s2} = - 2640.5536925 eV with n=1, k=1, j=-1, s=1/2, Z=14

Electrons of the sublevel n=2 and k=1 have energies

E_{2s1} = - 858.782309959 eV with n=2, k=1, j=1, s=1/2, Z=12

E_{2s2} = - 858.627957512 eV with n=2, k=1, j=2, s=1, Z=12

E_{2s3} = - 858.370703442 eV with n=2, k=1, j=-1, s=1/2, Z=12

E_{2s4} = - 856.981531453 eV with n=2, k=1, j=-2, s=1, Z=12

Energies of the sub-level p of the level 2

E_{2p1} = - 490.732748548 eV with n=2, k=2, j=1, s=1/2 Z=12

E_{2p2} = - 490.64454715 eV with n=2, k=2, j=2, s=1 Z=12

E_{2p3} = - 490.497544825 eV with n=2, k=2, j=-1, s=1/2 Z=12

E_{2p4} = - 489.703732259 eV with n=2, k=2, j=-2, s=1 Z=12

Level n=3

E_{3s1} = - 45.777479086 eV n=3, k=1, j=1, s=1/2 Z=4

E_{3s2} = - 45.7772985139 eV n=3, k=1, j=2, s=1 Z=4

E_{3s3} = - 45.7769975619 eV n=3, k=1, j=3, s=3/2 Z=4

E_{3s4} = - 45.7769975619 eV n=3, k=1, j=-1, s=1/2 Z=4

15. Energy levels of electrons in phosphorus atom P (Z=15)

First level n=1

E_{1s1} = - 3067.24301432 eV n=1, k=1, j=1, s=1/2, Z=15

E_{1s2} = - 3056.92733022 eV n=1, k=1, j=-1, s=1/2, Z=15

Second level n=2, first sub-level s k=1

E_{2s1} = - 1007.86597777 eV n=2, k=1, j=1, s=1/2, Z=13

E_{2s2} = - 1007.65337843 eV n=2, k=1, j=2, s=1, Z=13

E_{2s3} = - 1007.29904618 eV n=2, k=1, j=-1, s=1/2, Z=13

E_{2s4} = - 1005.38565204 eV n=2, k=1, j=-2, s=1, Z=13

Second sub-level p, k=2

E_{2p1} = - 575.923415877 eV n=2, k=2, j=1, s=1/2 Z=13

E_{2p2} = - 575.801930532 eV n=2, k=2, j=2, s=1 Z=13

E_{2p3} = - 575.599454963 eV n=2, k=2, j=-1, s=1/2 Z=13

E_{2p4} = - 574.506086876 eV n=2, k=2, j=-2, s=1 Z=13

Level n=3

E_{3s1} = - 71.5272581699 eV n=3, k=1, j=1, s=1/2 Z=5

E_{3s2} = - 71.5268173216 eV n=3, k=1, j=2, s=1 Z=5

E_{3s3} = - 71.5260825737 eV n=3, k=1, j=3, s=3/2 Z=5

E_{3s4} = - 71.5260825737 eV n=3, k=1, j=-1, s=1/2 Z=5

E_{3s5} = - 71.5271935128 eV n=3, k=1, j=-2, s=1 Z=5

16. Energy levels of electrons in sulphur atom S (Z=16)

First level n=1

E_{1s1} = - 3483.91729141 eV n=1, k=1, j=1, s=1/2, Z=16

E_{1s2} = - 3436.34225694 eV n=1, k=1, j=-1, s=1/2, Z=16

Level n=2, sub-level s

E_{2s1} = - 1168.87285539 eV n=2, k=1, j=1, s=1/2, Z=14

E_{2s2} = - 1168.58689844 eV n=2, k=1, j=2, s=1, Z=14

E_{2s3} = - 1168.11030351 eV n=2, k=1, j=-1, s=1/2, Z=14

E_{2s4} = - 1165.5366909 eV n=2, k=1, j=-2, s=1, Z=14

Level n=2, sub-level p

E_{2p1} = - 667.927345943 eV n=2, k=2, j=1, s=1/2 Z=14

E_{2p2} = - 667.763941969 eV n=2, k=2, j=2, s=1 Z=14

E_{2p3} = - 667.491602007 eV n=2, k=2, j=-1, s=1/2 Z=14

E_{2p4} = - 666.020966233 eV n=2, k=2, j=-2, s=1 Z=14

Level n=3, sub-level s

E_{3s1} = - 102.999158658 eV n=3, k=1, j=1, s=1/2 Z=6

E_{3s2} = - 102.998244514 eV n=3, k=1, j=2, s=1 Z=6

E_{3s3} = - 102.996720942 eV n=3, k=1, j=3, s=3/2 Z=6

E_{3s4} = - 102.996720942 eV n=3, k=1, j=-1, s=1/2 Z=6

E_{3s5} = - 102.988493651 eV n=3, k=1, j=-2, s=1 Z=6

E_{3s6} = - 102.97477815 eV n=3, k=1, j=-3, s=3/2 Z=6

17. Energy levels of electrons in chlorine atom Cl (Z=17)

First level n=1

E_{1s1} = - 3932.15059666 eV n=1, k=1, j=1, s=1/2 Z=17

E_{1s2} = - 3871.51957776 eV n=1, k=1, j=-1, s=1/2 Z=17

Level n=2, sub-level s k=1

E_{2s1} = - 1341.80213886 eV n=2, k=1, j=1, s=1/2, Z=15

E_{2s2} = - 1341.42530183 eV n=2, k=1, j=2, s=1, Z=15

E_{2s3} = - 1340.79724014 eV n=2, k=1, j=-1, s=1/2, Z=15

E_{2s4} = - 1337.40570696 eV n=2, k=1, j=-2, s=1, Z=15

Level n=2, sub-level p k=2

E_{2p1} = - 766.744079354 eV n=2, k=2, j=1, s=1/2 Z=15

E_{2p2} = - 766.528743911 eV n=2, k=2, j=2, s=1 Z=15

E_{2p3} = - 766.169851514 eV n=2, k=2, j=-1, s=1/2 Z=15

E_{2p4} = - 764.231832554 eV n=2, k=2, j=-2, s=1 Z=15

Level n=3, sub-level s

E_{3s1} = - 140.193149513 eV n=3, k=1, j=1, s=1/2 Z=7

E_{3s2} = - 140.191455951 eV n=3, k=1, j=2, s=1 Z=7

E_{3s3} = - 140.188633344 eV n=3, k=1, j=3, s=3/2 Z=7

E_{3s4} = - 140.188633344 eV n=3, k=1, j=-1, s=1/2 Z=7

E_{3s5} = - 140.173391273 eV n=3, k=1, j=-2, s=1 Z=7

E_{3s6} = - 140.157584679 eV n=3, k=1, j=-3, s=3/2 Z=7

Level n=3, sub-level p

E_{3p1} = - 115.453181952 eV n=3, k=2, j=1, s=1/2 Z=7

18. Energy levels of electrons in argon atom Ar (Z=18)

Level n=1

E_{1s1} = - 4407.33359033 eV n=1, k=1, j=1, s=1/2 Z=18

E_{1s2} = - 4331.12758418 eV n=1, k=1, j=-1, s=1/2 Z=18

Level n=2, sub-level s

E_{2s1} = - 1526.65296471 eV n=2, k=1, j=1, s=1/2, Z=16

E_{2s2} = - 1526.16513477 eV n=2, k=1, j=2, s=1, Z=16

E_{2s3} = - 1525.35208486 eV n=2, k=1, j=-1, s=1/2, Z=16

E_{2s4} = - 1520.96161537 eV n=2, k=1, j=-2, s=1, Z=16

Level n=2, sub-level p

E_{2p1} = - 872.373122695 eV n=2, k=2, j=1, s=1/2 Z=16

E_{2p2} = - 872.094362727 eV n=2, k=2, j=2, s=1 Z=16

E_{2p3} = - 871.629762781 eV n=2, k=2, j=-1, s=1/2 Z=16

E_{2p4} = - 869.120923073 eV n=2, k=2, j=-2, s=1 Z=16

Level n=3, sub-level s

E_{3s1} = - 183.109194058 eV n=3, k=1, j=1, s=1/2 Z=8

E_{3s2} = - 183.106304913 eV n=3, k=1, j=2, s=1 Z=8

E_{3s3} = - 183.101489673 eV n=3, k=1, j=3, s=3/2 Z=8

E_{3s4} = - 183.101489673 eV n=3, k=1, j=-1, s=1/2 Z=8

E_{3s5} = - 183.075487371 eV n=3, k=1, j=-2, s=1 Z=8

E_{3s6} = - 183.048522022 eV n=3, k=1, j=-3, s=3/2 Z=8

Level n=3, sub-level p

E_{3p1} = - 150.795806871 eV n=3, k=2, j=1, s=1/2 Z=8

E_{3p2} = - 150.793427575 eV n=3, k=2, j=2 s=1 Z=8

The 6 electrons of the first sub-level s of the level n=3 and the first two electrons of the second sub-level p of the level n=3 constitute an atomic structure composed of 8 electrons that the experimental evidence shows to be stablest: in fact argon Ar belongs to the group

of inert noble gases. This fact represents an important aspect for understanding and for calculation of energy levels of subsequent elements.

19. Energy levels of electrons in potassium atom K (Z=19)

Level n=1

E_{1s1} = - 4909.4281608 eV n=1, k=1, j=1, s=1/2 Z=19

E_{1s2} = - 4814.82327084 eV n=1, k=1, j=-1, s=1/2 Z=19

Level n=2, sub-level s

E_{2s1} = - 1723.42440994 eV n=2, k=1, j=1, s=1/2, Z=17

E_{2s2} = - 1722.80270516 eV n=2, k=1, j=2, s=1, Z=17

E_{2s3} = - 1723.62519119 eV n=2, k=1, j=-1, s=1/2, Z=17

E_{2s4} = - 1721.76653052 eV n=2, k=1, j=-2, s=1, Z=17

Level n=2, sub-level p

E_{2p1} = - 984.813948541 eV n=2, k=2, j=1, s=1/2 Z=17

E_{2p2} = - 984.458688665 eV n=2, k=2, j=2, s=1 Z=17

E_{2p3} = - 983.866588868 eV n=2, k=2, j=-1, s=1/2 Z=17

E_{2p4} = - 980.669249985 eV n=2, k=2, j=-2, s=1 Z=17

Level n=3, sub-level s

E_{3s1} = - 231.747249972 eV n=3, k=1, j=1, s=1/2 Z=9

E_{3s2} = - 231.742622121 eV n=3, k=1, j=2, s=1 Z=9

E_{3s3} = - 231.734909036 eV n=3, k=1, j=3, s=3/2 Z=9

E_{3s4} = - 231.734909036 eV n=3, k=1, j=-1, s=1/2 Z=9

E_{3s5} = - 231.693258376 eV n=3, k=1, j=-2, s=1 Z=9

E_{3s6} = - 231.650065099 eV n=3, k=1, j=-3, s=3/2 Z=9

Level n=3, sub-level p

E_{3p1} = - 190.850676448 eV n=3, k=2, j=1, s=1/2 Z=9

E_{3p2} = - 190.846865276 eV n=3, k=2, j=2 s=1 Z=9

The stablest structure 6+2 of electrons of the first sub-level 3s and of the first two electrons of the sub-level 3p, as it has been pointed out for argon, allows to assume the last electron of potassium is effectively shielded by all preceding 18 electrons for which in calculation of its energy it needs to consider a value Z=1. This effect of shielding is valid also for all subsequent chemical elements. Hence

E_{3p3} = - 2.35619513188 eV n=3, k=2, j=3 s=3/2 Z=1

20. Energy levels of electrons in calcium atom Ca (Z=20)

Level n=1

E_{1s1} = - 5438.39401846 eV n=1, k=1, j=1, s=1/2 Z=20

E_{1s2} = - 5322.24403196 eV n=1, k=1, j=-1, s=1/2 Z=20

Level n=2, sub-level s

E_{2s1} = - 1932.11549199 eV n=2, k=1, j=1, s=1/2, Z=18

E_{2s2} = - 1931.33408275 eV n=2, k=1, j=2, s=1, Z=18

E_{2s3} = - 1930.031734 eV n=2, k=1, j=-1, s=1/2, Z=18

E_{2s4} = - 1922.99905082 eV n=2, k=1, j=-2, s=1, Z=18

Level n=2, sub-level p

E_{2p1} = - 1104.06599542 eV n=2, k=2, j=1, s=1/2 Z=18

E_{2p2} = - 1103.61947585 eV n=2, k=2, j=2, s=1 Z=18

E_{2p3} = - 1102.87527657 eV n=2, k=2, j=-1, s=1/2 Z=18

E_{2p4} = - 1098.85660047 eV n=2, k=2, j=-2, s=1 Z=18

Level n=3, sub-level s

E_{3s1} = - 286.107269284 eV n=3, k=1, j=1, s=1/2 Z=10

E_{3s2} = - 286.100215709 eV n=3, k=1, j=2, s=1 Z=10

E_{3s3} = - 286.088459753 eV n=3, k=1, j=3, s=3/2 Z=10

E_{3s4} = - 286.088459753 eV n=3, k=1, j=-1, s=1/2 Z=10

E_{3s5} = - 286.02497757 eV n=3, k=1, j=-2, s=1 Z=10

E_{3s6} = - 285.959144197 eV n=3, k=1, j=-3, s=3/2 Z=10

Level n=3, sub-level p

E_{3p1} = - 235.617751176 eV n=3, k=2, j=1, s=1/2 Z=10

E_{3p2} = - 235.61194235 eV n=3, k=2, j=2 s=1 Z=10

Considering the shielding effect of the first 8 electrons of the level n=3, as in the event of argon, for calculation of energies of subsequent electrons, it needs to assume Z=2:

E_{3p3} = - 9.4247596156 eV n=3, k=2, j=3 s=3/2 Z=2

E_{3p4} = - 9.4247596156 eV n=3, k=2, j=-1 s=1/2 Z=2

21. Energy levels of electrons in scandium atom Sc (Z=21)

Level n=1

E_{1s1} = - 5994.18869609 eV n=1, k=1, j=1, s=1/2 Z=21

E_{1s2} = - 5853.00766155 eV n=1, k=1, j=-1, s=1/2 Z=21

Level n=2, sub-level s

E_{2s1} = - 2152.72516871 eV n=2, k=1, j=1, s=1/2, Z=19

E_{2s2} = - 2151.75509902 eV n=2, k=1, j=2, s=1, Z=19

E_{2s3} = - 2150.13831624 eV n=2, k=1, j=-1, s=1/2, Z=19

E_{2s4} = - 2141.4076892 eV n=2, k=1, j=-2, s=1, Z=19

Level n=2, sub-level p

E_{2p1} = - 1230.12866783 eV n=2, k=2, j=1, s=1/2 Z=19

E_{2p2} = - 1229.5743423 eV n=2, k=2, j=2, s=1 Z=19

E_{2p3} = - 1228.65046642 eV n=2, k=2, j=-1, s=1/2 Z=19

E_{2p4} = - 1223.66153669 eV n=2, k=2, j=-2, s=1 Z=19

Level n=3, sub-level s

E_{3s1} = - 346.189198396 eV n=3, k=1, j=1, s=1/2 Z=11

E_{3s2} = - 346.178871259 eV n=3, k=1, j=2, s=1 Z=11

E_{3s3} = - 346.161659355 eV n=3, k=1, j=3, s=3/2 Z=11

E_{3s4} = - 346.161659355 eV n=3, k=1, j=-1, s=1/2 Z=11

E_{3s5} = - 346.068715097 eV n=3, k=1, j=-2, s=1 Z=11

E_{3s6} = - 345.913807994 eV n=3, k=1, j=-3, s=3/2 Z=11

Level n=3, sub-level p

E_{3p1} = - 285.096986913 eV n=3, k=2, j=1, s=1/2 Z=11

E_{3p2} = - 285.088482212 eV n=3, k=2, j=2 s=1 Z=11

E_{3p3} = - 21.2056307162 eV n=3, k=2, j=3 s=3/2 Z=3

E_{3p4} = - 21.2056307162 eV n=3, k=2, j=-1 s=1/2 Z=3

E_{3p5} = - 21.2052072528 eV n=3, k=2, j=-2 s=1 Z=3

22. Energy levels of electrons in titanium atom Ti (Z=22)

Level n=1

E_{1s1} = - 6576.7675484 eV n=1, k=1, j=1, s=1/2 Z=22

E_{1s2} = - 6406.71235318 eV n=1, k=1, j=-1, s=1/2 Z=22

Level n=2, sub-level s

E_{2s1} = - 2385.25233846 eV n=2, k=1, j=1, s=1/2, Z=20

E_{2s2} = - 2384.06134737 eV n=2, k=1, j=2, s=1, Z=20

E_{2s3} = - 2382.07636226 eV n=2, k=1, j=-1, s=1/2, Z=20

E_{2s4} = - 2271.35744226 eV n=2, k=1, j=-2, s=1, Z=20

Level n=2, sub-level p

E_{2p1} = - 1363.00133626 eV n=2, k=2, j=1, s=1/2 Z=20

E_{2p2} = - 1362.32076993 eV n=2, k=2, j=2, s=1 Z=20

E_{2p3} = - 1361.18649272 eV n=2, k=2, j=-1, s=1/2 Z=20

E_{2p4} = - 1355.06139577 eV n=2, k=2, j=-2, s=1 Z=20

Level n=3, sub-level s

E_{3s1} = - 411.992978056 eV n=3, k=1, j=1, s=1/2 Z=12

E_{3s2} = - 411.97835176 eV n=3, k=1, j=2, s=1 Z=12

E_{3s3} = - 411.953974604 eV n=3, k=1, j=3, s=3/2 Z=12

E_{3s4} = - 411.953974604 eV n=3, k=1, j=-1, s=1/2 Z=12

E_{3s5} = - 411.822337952 eV n=3, k=1, j=-2, s=1 Z=12

E_{3s6} = - 411.685825868 eV n=3, k=1, j=-3, s=3/2 Z=12

Level n=3, sub-level p

E_{3p1} = - 339.288334867 eV n=3, k=2, j=1, s=1/2 Z=12

E_{3p2} = - 339.276289683 eV n=3, k=2, j=2 s=1 Z=12

E_{3p3} = - 37.6987038741 eV n=3, k=2, j=3 s=3/2 Z=4

E_{3p4} = - 37.6987038741 eV n=3, k=2, j=-1 s=1/2 Z=4

E_{3p5} = - 37.6973655205 eV n=3, k=2, j=-2 s=1 Z=4

E_{3p6} = - 37.695134931 eV n=3, k=2, j=-3 s=3/2 Z=4

23. Energy levels of electrons in vanadium atom V (Z=23)

Level n=1

E_{1s1} = - 7186.08375257 eV n=1, k=1, j=1, s=1/2 Z=23

E_{1s2} = - 6982.93670022 eV n=1, k=1, j=-1, s=1/2 Z=23

Level n=2, sub-level s

E_{2s1} = - 2629.69583998 eV n=2, k=1, j=1, s=1/2, Z=21

E_{2s2} = - 2628.2481829 eV n=2, k=1, j=2, s=1, Z=21

E_{2s3} = - 2625.83542108 eV n=2, k=1, j=-1, s=1/2, Z=21

E_{2s4} = - 2612.80650724 eV n=2, k=1, j=-2, s=1, Z=21

Level n=2, sub-level p

E_{2p1} = - 1502.68333713 eV n=2, k=2, j=1, s=1/2 Z=21

E_{2p2} = - 1501.85610451 eV n=2, k=2, j=2, s=1 Z=21

E_{2p3} = - 1500.47738347 eV n=2, k=2, j=-1, s=1/2 Z=21

E_{2p4} = - 1493.0322619 eV n=2, k=2, j=-2, s=1 Z=21

Level n=3, sub-level s

E_{3s1} = - 483.518543368 eV n=3, k=1, j=1, s=1/2 Z=13

E_{3s2} = - 483.49839765 eV n=3, k=1, j=2, s=1 Z=13

E_{3s3} = - 483.464821454 eV n=3, k=1, j=3, s=3/2 Z=13

E_{3s4} = - 483.464821454 eV n=3, k=1, j=-1, s=1/2 Z=13

E_{3s5} = - 483.28351 eV n=3, k=1, j=-2, s=1 Z=13

E_{3s6} = - 482.981324235 eV n=3, k=1, j=-3, s=3/2 Z=13

Level n=3, sub-level p

E_{3p1} = - 398.191741593 eV n=3, k=2, j=1, s=1/2 Z=13

E_{3p2} = - 398.175151005 eV n=3, k=2, j=2 s=1 Z=13

E_{3p3} = - 58.903832708 eV n=3, k=2, j=3 s=3/2 Z=5

E_{3p4} = - 58.903832708 eV n=3, k=2, j=-1 s=1/2 Z=5

E_{3p5} = - 58.9005652434 eV n=3, k=2, j=-2 s=1 Z=5

E_{3p6} = - 58.8951194677 eV n=3, k=2, j=-3 s=3/2 Z=5

Level n=3, sub-level d

E_{3d1} = - 37.8673719723 eV n=3, k=3, j=1, s=1/2 Z=5

24. Energy levels of electrons in chromium atom Cr (Z=24)

Level n=1

E_{1s1} = - 7822.08830765 eV n=1, k=1, j=1, s=1/2 Z=24

E_{1s2} = - 7581.23969562 eV n=1, k=1, j=-1, s=1/2 Z=24

Level n=2, sub-level s

E_{2s1} = - 2886.05445257 eV n=2, k=1, j=1, s=1/2, Z=22

E_{2s2} = - 2884.31072255 eV n=2, k=1, j=2, s=1, Z=22

E_{2s3} = - 2881.40450583 eV n=2, k=1, j=-1, s=1/2, Z=22

E_{2s4} = - 2865.71093556 eV n=2, k=1, j=-2, s=1, Z=22

Level n=2, sub-level p

E_{2p1} = - 1649.1739729 eV n=2, k=2, j=1, s=1/2 Z=22

E_{2p2} = - 11648.17755575 eV n=2, k=2, j=2, s=1 Z=22

E_{2p3} = - 1646.5168047 eV n=2, k=2, j=-1, s=1/2 Z=22

E_{2p4} = - 1637.54910603 eV n=2, k=2, j=-2, s=1 Z=22

Level n=3, sub-level s

E_{3s1} = - 560.765823801 eV n=3, k=1, j=1, s=1/2 Z=14

E_{3s2} = - 560.752516614 eV n=3, k=1, j=2, s=1 Z=14

E_{3s3} = - 560.693565089 eV n=3, k=1, j=3, s=3/2 Z=14

E_{3s4} = - 560.693565089 eV n=3, k=1, j=-1, s=1/2 Z=14

E_{3s5} = - 560.77319714 eV n=3, k=1, j=-2, s=1 Z=14

E_{3s6} = - 560.771123389 eV n=3, k=1, j=-3, s=3/2 Z=14

Level n=3, sub-level p

E_{3p1} = - 461.80714901 eV n=3, k=2, j=1, s=1/2 Z=14

E_{3p2} = - 461.784833823 eV n=3, k=2, j=2 s=1 Z=14

E_{3p3} = - 84.8208290113 eV n=3, k=2, j=3 s=3/2 Z=6

E_{3p4} = - 84.8208290113 eV n=3, k=2, j=-1 s=1/2 Z=6

E_{3p5} = - 84.8140535951 eV n=3, k=2, j=-2 s=1 Z=6

E_{3p6} = - 84.8027612358 eV n=3, k=2, j=-3 s=3/2 Z=6

Level n=3, sub-level d

E_{3d1} = - 54.5289663488 eV n=3, k=3, j=1, s=1/2 Z=6

E_{3d2} = - 54.5284823902 eV n=3, k=3, j=2 s=1 Z=6

25. Energy levels of electrons in manganese atom Mn (Z=25)

Level n=1

E_{1s1} = - 8484.73003527 eV n=1, k=1, j=1, s=1/2 Z=25

E_{1s2} = - 8201.16073228 eV n=1, k=1, j=-1, s=1/2 Z=25

Level n=2, sub-level s

E_{2s1} = - 3154.32689588 eV n=2, k=1, j=1, s=1/2, Z=23

E_{2s2} = - 3152.24384506 eV n=2, k=1, j=2, s=1, Z=23

E_{2s3} = - 3148.77209366 eV n=2, k=1, j=-1, s=1/2, Z=23

E_{2s4} = - 3130.0246362 eV n=2, k=1, j=-2, s=1, Z=23

Level n=2, sub-level p

E_{2p1} = - 1802.47251193 eV n=2, k=2, j=1, s=1/2 Z=23

E_{2p2} = - 1801.28219718 eV n=2, k=2, j=2, s=1 Z=23

E_{2p3} = - 1799.29833924 eV n=2, k=2, j=-1, s=1/2 Z=23

E_{2p4} = - 1788.58550641 eV n=2, k=2, j=-2, s=1 Z=23

Level n=3, sub-level s

E_{3s1} = - 643.734743165 eV n=3, k=1, j=1, s=1/2 Z=15

E_{3s2} = - 643.699034444 eV n=3, k=1, j=2, s=1 Z=15

E_{3s3} = - 643.639519898 eV n=3, k=1, j=3, s=3/2 Z=15

E_{3s4} = - 643.639519898 eV n=3, k=1, j=-1, s=1/2 Z=15

E_{3s5} = - 643.318141352 eV n=3, k=1, j=-2, s=1 Z=15

E_{3s6} = - 642.78251045 eV n=3, k=1, j=-3, s=3/2 Z=15

Level n=3, sub-level p

E_{3p1} = - 530.134494373 eV n=3, k=2, j=1, s=1/2 Z=15

E_{3p2} = - 530.10508719 eV n=3, k=2, j=2 s=1 Z=15

E_{3p3} = - 115.449462754 eV n=3, k=2, j=3 s=3/2 Z=7

E_{3p4} = - 115.449462754 eV n=3, k=2, j=-1 s=1/2 Z=7

E_{3p5} = - 115.43691046 eV n=3, k=2, j=-2 s=1 Z=7

E_{3p6} = - 115.415989969 eV n=3, k=2, j=-3 s=3/2 Z=7

Level n=3, sub-level d

E_{3d1} = - 74.2199026837 eV n=3, k=3, j=1, s=1/2 Z=7

E_{3d2} = - 74.2190060918 eV n=3, k=3, j=2 s=1 Z=7

E_{3d3} = - 74.2175117704 eV n=3, k=3, j=3 s=3/2 Z=7

26. Energy levels of electrons in iron atom Fe (Z=26)

Level n=1

E_{1s1} = - 9173.95557883 eV n=1, k=1, j=1, s=1/2 Z=26

E_{1s2} = - 8842.21960237 eV n=1, k=1, j=-1, s=1/2 Z=26

Level n=2, sub-level s

E_{2s1} = - 3432.04219094 eV n=2, k=1, j=1, s=1/2, Z=24

E_{2s2} = - 3422.16363457 eV n=2, k=1, j=2, s=1, Z=24

E_{2s3} = - 3405.69937399 eV n=2, k=1, j=-1, s=1/2, Z=24

E_{2s4} = - 3316.79236683 eV n=2, k=1, j=-2, s=1, Z=24

Level n=2, sub-level p

E_{2p1} = - 1962.5781886 eV n=2, k=2, j=1, s=1/2 Z=24

E_{2p2} = - 1961.16696625 eV n=2, k=2, j=2, s=1 Z=24

E_{2p3} = - 1958.81492904 eV n=2, k=2, j=-1, s=1/2 Z=24

E_{2p4} = - 1946.113928 eV n=2, k=2, j=-2, s=1 Z=24

Level n=3, sub-level s

E_{3s1} = - 732.425219652 eV n=3, k=1, j=1, s=1/2 Z=16

E_{3s2} = - 732.378993339 eV n=3, k=1, j=2, s=1 Z=16

E_{3s3} = - 732.301949481 eV n=3, k=1, j=3, s=3/2 Z=16

E_{3s4} = - 732.301949481 eV n=3, k=1, j=-1, s=1/2 Z=16

E_{3s5} = - 731.885912655 eV n=3, k=1, j=-2, s=1 Z=16

E_{3s6} = - 731.19251795 eV n=3, k=1, j=-3, s=3/2 Z=16

Level n=3, sub-level p

E_{3p1} = - 603.1737103 eV n=3, k=2, j=1, s=1/2 Z=16

E_{3p2} = - 603.135641569 eV n=3, k=2, j=2 s=1 Z=16

E_{3p3} = - 150.789462082 eV n=3, k=2, j=3 s=3/2 Z=8

E_{3p4} = - 150.789462082 eV n=3, k=2, j=-1 s=1/2 Z=8

E_{3p5} = - 150.768048422 eV n=3, k=2, j=-2 s=1 Z=8

E_{3p6} = - 150.732358989 eV n=3, k=2, j=-3 s=3/2 Z=8

Level n=3, sub-level d

E_{3d1} = - 96.9401615605 eV n=3, k=3, j=1, s=1/2 Z=8

E_{3d2} = - 96.938632013 eV n=3, k=3, j=2 s=1 Z=8

E_{3d3} = - 96.9360827681 eV n=3, k=3, j=3 s=3/2 Z=8

E_{3d4} = - 96.9360827681 eV n=3, k=3, j=-1 s=1/2 Z=8

27. Energy levels of electrons in cobalt atom Co (Z=27)

Level n=1

E_{1s1} = - 9889.70940425 eV n=1, k=1, j=1, s=1/2 Z=27

E_{1s2} = - 9503.91649816 eV n=1, k=1, j=-1, s=1/2 Z=27

Level n=2, sub-level s

E_{2s1} = - 3726.60785565 eV n=2, k=1, j=1, s=1/2, Z=25

E_{2s2} = - 3723.70016261 eV n=2, k=1, j=2, s=1, Z=25

E_{2s3} = - 3718.85400752 eV n=2, k=1, j=-1, s=1/2, Z=25

E_{2s4} = - 3692.68477009 eV n=2, k=1, j=-2, s=1, Z=25

Level n=2, sub-level p

E_{2p1} = - 2129.49020324 eV n=2, k=2, j=1, s=1/2 Z=25

E_{2p2} = - 2127.82866436 eV n=2, k=2, j=2, s=1 Z=25

E_{2p3} = - 2125.05943288 eV n=2, k=2, j=-1, s=1/2 Z=25

E_{2p4} = - 2110.10558291 eV n=2, k=2, j=-2, s=1 Z=25

Level n=3, sub-level s

E_{3s1} = - 826.837165794 eV n=3, k=1, j=1, s=1/2 Z=17

E_{3s2} = - 826.778253629 eV n=3, k=1, j=2, s=1 Z=17

E_{3s3} = - 826.680066674 eV n=3, k=1, j=3, s=3/2 Z=17

E_{3s4} = - 826.680066674 eV n=3, k=1, j=-1, s=1/2 Z=17

E_{3s5} = - 826.149857153 eV n=3, k=1, j=-2, s=1 Z=17

E_{3s6} = - 825.266174606 eV n=3, k=1, j=-3, s=3/2 Z=17

Level n=3, sub-level p

E_{3p1} = - 680.92472477 eV n=3, k=2, j=1, s=1/2 Z=17

E_{3p2} = - 680.876208869 eV n=3, k=2, j=2 s=1 Z=17

E_{3p3} = - 190.840513322 eV n=3, k=2, j=3 s=3/2 Z=9

E_{3p4} = - 190.840513322 eV n=3, k=2, j=-1 s=1/2 Z=9

E_{3p5} = - 190.806212779 eV n=3, k=2, j=-2 s=1 Z=9

E_{3p6} = - 150.732358989 eV n=3, k=2, j=-3 s=3/2 Z=9

Level n=3, sub-level d

E_{3d1} = - 122.689720573 eV n=3, k=3, j=1, s=1/2 Z=9

E_{3d2} = - 122.687270534 eV n=3, k=3, j=2 s=1 Z=9

E_{3d3} = - 122.683187137 eV n=3, k=3, j=3 s=3/2 Z=9

E_{3d4} = - 122.683187137 eV n=3, k=3, j=-1 s=1/2 Z=9

E_{3d5} = - 122.661136787 eV n=3, k=3, j=-2 s=1 Z=9

28. Energy levels of electrons in nickel atom Ni (Z=28)

Level n=1

E_{1s1} = - 10631.9337993 eV n=1, k=1, j=1, s=1/2 Z=28

E_{1s2} = - 10185.7320111 eV n=1, k=1, j=-1, s=1/2 Z=28

Level n=2, sub-level s

E_{2s1} = - 4030.61351371 eV n=2, k=1, j=1, s=1/2, Z=26

E_{2s2} = - 4027.21192416 eV n=2, k=1, j=2, s=1, Z=26

E_{2s3} = - 4021.54260816 eV n=2, k=1, j=-1, s=1/2, Z=26

E_{2s4} = - 3990.92830171 eV n=2, k=1, j=-2, s=1, Z=26

Level n=2, sub-level p

E_{2p1} = - 2303.20772213 eV n=2, k=2, j=1, s=1/2 Z=26

E_{2p2} = - 2301.26395666 eV n=2, k=2, j=2, s=1 Z=26

E_{2p3} = - 2298.02434752 eV n=2, k=2, j=-1, s=1/2 Z=26

E_{2p4} = - 2280.53045813 eV n=2, k=2, j=-2, s=1 Z=26

Level n=3, sub-level s

E_{3s1} = - 926.970488481 eV n=3, k=1, j=1, s=1/2 Z=18

E_{3s2} = - 926.896442861 eV n=3, k=1, j=2, s=1 Z=18

E_{3s3} = - 926.773033504 eV n=3, k=1, j=3, s=3/2 Z=18

E_{3s4} = - 926.773033504 eV n=3, k=1, j=-1, s=1/2 Z=18

E_{3s5} = - 926.106622953 eV n=3, k=1, j=-2, s=1 Z=18

E_{3s6} = - 924.995938711 eV n=3, k=1, j=-3, s=3/2 Z=18

Level n=3, sub-level p

E_{3p1} = - 763.387461101 eV n=3, k=2, j=1, s=1/2 Z=18

E_{3p2} = - 763.326482355 eV n=3, k=2, j=2 s=1 Z=18

E_{3p3} = - 235.602260973 eV n=3, k=2, j=3 s=3/2 Z=10

E_{3p4} = - 235.602260973 eV n=3, k=2, j=-1 s=1/2 Z=10

E_{3p5} = - 235.549981528 eV n=3, k=2, j=-2 s=1 Z=10

E_{3p6} = - 235.462849123 eV n=3, k=2, j=-3 s=3/2 Z=10

Level n=3, sub-level d

E_{3d1} = - 151.468554328 eV n=3, k=3, j=1, s=1/2 Z=10

E_{3d2} = - 151.464820082 eV n=3, k=3, j=2 s=1 Z=10

E_{3d3} = - 151.45859634 eV n=3, k=3, j=3 s=3/2 Z=10

E_{3d4} = - 151.45859634 eV n=3, k=3, j=-1 s=1/2 Z=10

E_{3d5} = - 151.424988125 eV n=3, k=3, j=-2 s=1 Z=10

E_{3d6} = - 151.368974436 eV n=3, k=3, j=-3 s=3/2 Z=10

29. Energy levels of electrons in copper atom Cu (Z=29)

Level n=1

E_{1s1} = - 11400.5688745 eV n=1, k=1, j=1, s=1/2 Z=29

E_{1s2} = - 10887.1271333 eV n=1, k=1, j=-1, s=1/2 Z=29

Level n=2, sub-level s

E_{2s1} = - 4346.5272858 eV n=2, k=1, j=1, s=1/2, Z=27

E_{2s2} = - 4342.5714015 eV n=2, k=1, j=2, s=1, Z=27

E_{2s3} = - 4335.97826101 eV n=2, k=1, j=-1, s=1/2, Z=27

E_{2s4} = - 4300.37530238 eV n=2, k=1, j=-2, s=1, Z=27

Level n=2, sub-level p

E_{2p1} = - 2483.72987761 eV n=2, k=2, j=1, s=1/2 Z=27

E_{2p2} = - 2481.4693723 eV n=2, k=2, j=2, s=1 Z=27

E_{2p3} = - 2477.70186344 eV n=2, k=2, j=-1, s=1/2 Z=27

E_{2p4} = - 2457.35731566 eV n=2, k=2, j=-2, s=1 Z=27

Level n=3, sub-level s

E_{3s1} = - 1032.82508895 eV n=3, k=1, j=1, s=1/2 Z=19

E_{3s2} = - 1032.73316605 eV n=3, k=1, j=2, s=1 Z=19

E_{3s3} = - 1032.57996121 eV n=3, k=1, j=3, s=3/2 Z=19

E_{3s4} = - 1032.57996121 eV n=3, k=1, j=-1, s=1/2 Z=19

E_{3s5} = - 1031.75265508 eV n=3, k=1, j=-2, s=1 Z=19

E_{3s6} = - 1030.37381152 eV n=3, k=1, j=-3, s=3/2 Z=19

Level n=3, sub-level p

E_{3p1} = - 850.561837966 eV n=3, k=2, j=1, s=1/2 Z=19

E_{3p2} = - 850.486136754 eV n=3, k=2, j=2 s=1 Z=19

E_{3p3} = - 285.074307703 eV n=3, k=2, j=3 s=3/2 Z=11

E_{3p4} = - 285.074307703 eV n=3, k=2, j=-1 s=1/2 Z=11

E_{3p5} = - 284.997765374 eV n=3, k=2, j=-2 s=1 Z=11

E_{3p6} = - 284.870194818 eV n=3, k=2, j=-3 s=3/2 Z=11

Level n=3, sub-level d

E_{3d1} = - 183.276634447 eV n=3, k=3, j=1, s=1/2 Z=11

E_{3d2} = - 183.271167137 eV n=3, k=3, j=2 s=1 Z=11

E_{3d3} = - 183.262054955 eV n=3, k=3, j=3 s=3/2 Z=11

E_{3d4} = - 183.262054955 eV n=3, k=3, j=-1 s=1/2 Z=11

E_{3d5} = - 183.212849169 eV n=3, k=3, j=-2 s=1 Z=11

E_{3d6} = - 183.130839527 eV n=3, k=3, j=-3 s=3/2 Z=11

The 3 sub-levels of the energy level n=3 are full, hence the twenty-ninth electron of atom occupies the first quantum state of the level n=4. Considering this electron is shielded by electric charge of preceding 28 electrons that fill completely the preceding levels, energy of this electron is given by

E_{4s1} = - 1.6507840953 eV n=4, k=1, j=1, s=1/2 Z=1

30. Energy levels of electrons in zinc atom Zn (Z=30)

Level n=1

E_{1s1} = - 12195.5525619 eV n=1, k=1, j=1, s=1/2 Z=30

E_{1s2} = - 11607.5432552 eV n=1, k=1, j=-1, s=1/2 Z=30

Level n=2, sub-level s

E_{2s1} = - 4674.34759377 eV n=2, k=1, j=1, s=1/2, Z=28

E_{2s2} = - 4669.77228243 eV n=2, k=1, j=2, s=1, Z=28

E_{2s3} = - 4662.14676361 eV n=2, k=1, j=-1, s=1/2, Z=28

E_{2s4} = - 4620.96896185 eV n=2, k=1, j=-2, s=1, Z=28

Level n=2, sub-level p

E_{2p1} = - 2671.05576787 eV n=2, k=2, j=1, s=1/2 Z=28

E_{2p2} = - 2668.44130426 eV n=2, k=2, j=2, s=1 Z=28

E_{2p3} = - 2664.08386493 eV n=2, k=2, j=-1, s=1/2 Z=28

E_{2p4} = - 2640.5536925 eV n=2, k=2, j=-2, s=1 Z=28

Level n=3, sub-level s

E_{3s1} = - 1144.40086284 eV n=3, k=1, j=1, s=1/2 Z=20

E_{3s2} = - 1144.28800563 eV n=3, k=1, j=2, s=1 Z=20

E_{3s3} = - 1144.09991028 eV n=3, k=1, j=3, s=3/2 Z=20

E_{3s4} = - 1144.09991028 eV n=3, k=1, j=-1, s=1/2 Z=20

E_{3s5} = - 1143.08419537 eV n=3, k=1, j=-2, s=1 Z=20

E_{3s6} = - 1141.3913372 eV n=3, k=1, j=-3, s=3/2 Z=20

Level n=3, sub-level p

E_{3p1} = - 942.447769404 eV n=3, k=2, j=1, s=1/2 Z=20

E_{3p2} = - 942.354828167 eV n=3, k=2, j=2 s=1 Z=20

E_{3p3} = - 339.256214378 eV n=3, k=2, j=3 s=3/2 Z=12

E_{3p4} = - 339.256214378 eV n=3, k=2, j=-1 s=1/2 Z=12

E_{3p5} = - 339.147807724 eV n=3, k=2, j=-2 s=1 Z=12

E_{3p6} = - 338.967129969 eV n=3, k=2, j=-3 s=3/2 Z=12

Level n=3, sub-level d

E_{3d1} = - 218.11392956 eV n=3, k=3, j=1, s=1/2 Z=12

E_{3d2} = - 218.106186227 eV n=3, k=3, j=2 s=1 Z=12

E_{3d3} = - 218.093280673 eV n=3, k=3, j=3 s=3/2 Z=12

E_{3d4} = - 218.093280673 eV n=3, k=3, j=-1 s=1/2 Z=12

E_{3d5} = - 218.02359068 eV n=3, k=3, j=-2 s=1 Z=12

E_{3d6} = - 217.907440694 eV n=3, k=3, j=-3 s=3/2 Z=12

Level n=4, sub-level s

E_{4s1} = - 6.60313586672 eV n=4, k=1, j=1, s=1/2 Z=2

E_{4s2} = - 6.60313380634 eV n=4, k=1, j=2, s=1 Z=2

31. Energy levels of electrons in gallium atom Ga (Z=31)

Level n=1

E_{1s1} = - 13016.8206162 eV n=1, k=1, j=1, s=1/2 Z=31

E_{1s2} = - 12346.4021682 eV n=1, k=1, j=-1, s=1/2 Z=31

Level n=2, sub-level s

E_{2s1} = - 5014.07279997 eV n=2, k=1, j=1, s=1/2, Z=29

E_{2s2} = - 5008.80801651 eV n=2, k=1, j=2, s=1, Z=29

E_{2s3} = - 5000.03337738 eV n=2, k=1, j=-1, s=1/2, Z=29

E_{2s4} = - 4952.65032608 eV n=2, k=1, j=-2, s=1, Z=29

Level n=2, sub-level p

E_{2p1} = - 2865.18445713 eV n=2, k=2, j=1, s=1/2 Z=29

E_{2p2} = - 2862.17600941 eV n=2, k=2, j=2, s=1 Z=29

E_{2p3} = - 2857.16192992 eV n=2, k=2, j=-1, s=1/2 Z=29

E_{2p4} = - 2830.08590062 eV n=2, k=2, j=-2, s=1 Z=29

Level n=3, sub-level s

E_{3s1} = - 1261.69770009 eV n=3, k=1, j=1, s=1/2 Z=21

E_{3s2} = - 1261.56052146 eV n=3, k=1, j=2, s=1 Z=21

E_{3s3} = - 1261.33189038 eV n=3, k=1, j=3, s=3/2 Z=21

E_{3s4} = - 1261.33189038 eV n=3, k=1, j=-1, s=1/2 Z=21

E_{3s5} = - 1260.09728256 eV n=3, k=1, j=-2, s=1 Z=21

E_{3s6} = - 1258.03960287 eV n=3, k=1, j=-3, s=3/2 Z=21

Level n=3, sub-level p

E_{3p1} = - 1039.04516478 eV n=3, k=2, j=1, s=1/2 Z=21

E_{3p2} = - 1038.93219414 eV n=3, k=2, j=2 s=1 Z=21

E_{3p3} = - 398.147500021 eV n=3, k=2, j=3 s=3/2 Z=13

E_{3p4} = - 398.147500021 eV n=3, k=2, j=-1 s=1/2 Z=13

E_{3p5} = - 397.998184705 eV n=3, k=2, j=-2 s=1 Z=13

E_{3p6} = - 397.749325839 eV n=3, k=2, j=-3 s=3/2 Z=13

Level n=3, sub-level d

E_{3d1} = - 255.980405313 eV n=3, k=3, j=1, s=1/2 Z=13

E_{3d2} = - 255.969739934 eV n=3, k=3, j=2 s=1 Z=13

E_{3d3} = - 255.9519643 eV n=3, k=3, j=3 s=3/2 Z=13

E_{3d4} = - 255.9519643 eV n=3, k=3, j=-1 s=1/2 Z=13

E_{3d5} = - 255.855975883 eV n=3, k=3, j=-2 s=1 Z=13

E_{3d6} = - 255.695995184 eV n=3, k=3, j=-3 s=3/2 Z=13

Level n=4, sub-level s

E_{4s1} = - 14.8570537686 eV n=4, k=1, j=1, s=1/2 Z=3

E_{4s2} = - 14.8570433383 eV n=4, k=1, j=2, s=1 Z=3

E_{4s3} = - 14.8570259544 eV n=4, k=1, j=3, s=3/2 Z=3

32. Energy levels of electrons in germanium atom Ge (Z=32)

Level n=1

E_{1s1} = - 13864.3066139 eV n=1, k=1, j=1, s=1/2 Z=32

E_{1s2} = - 13103.1060624 eV n=1, k=1, j=-1, s=1/2 Z=32

Level n=2, sub-level s

E_{2s1} = - 5365.70120737 eV n=2, k=1, j=1, s=1/2, Z=30

E_{2s2} = - 5359.67181509 eV n=2, k=1, j=2, s=1, Z=30

E_{2s3} = - 55349.62282788 eV n=2, k=1, j=-1, s=1/2, Z=30

E_{2s4} = - 5295.35829716 eV n=2, k=1, j=-2, s=1, Z=30

Level n=2, sub-level p

E_{2p1} = - 3066.11497563 eV n=2, k=2, j=1, s=1/2 Z=30

E_{2p2} = - 3062.66960862 eV n=2, k=2, j=2, s=1 Z=30

E_{2p3} = - 3056.92733022 eV n=2, k=2, j=-1, s=1/2 Z=30

E_{2p4} = - 3025.91902695 eV n=2, k=2, j=-2, s=1 Z=30

Level n=3, sub-level s

E_{3s1} = - 1384.71548503 eV n=3, k=1, j=1, s=1/2 Z=22

E_{3s2} = - 1384.55025079 eV n=3, k=1, j=2, s=1 Z=22

E_{3s3} = - 1384.27486039 eV n=3, k=1, j=3, s=3/2 Z=22

E_{3s4} = - 1384.27486039 eV n=3, k=1, j=-1, s=1/2 Z=22

E_{3s5} = - 1382.78775219 eV n=3, k=1, j=-2, s=1 Z=22

E_{3s6} = - 1380.30923855 eV n=3, k=1, j=-3, s=3/2 Z=22

Level n=3, sub-level p

E_{3p1} = - 1140.35392884 eV n=3, k=2, j=1, s=1/2 Z=22

E_{3p2} = - 1140.21785359 eV n=3, k=2, j=2 s=1 Z=22

E_{3p3} = - 461.747641839 eV n=3, k=2, j=3 s=3/2 Z=14

E_{3p4} = - 461.747641839 eV n=3, k=2, j=-1 s=1/2 Z=14

E_{3p5} = - 461.546805124 eV n=3, k=2, j=-2 s=1 Z=14

E_{3p6} = - 461.212077277 eV n=3, k=2, j=-3 s=3/2 Z=14

Level n=3, sub-level d

E_{3d1} = - 296.876024366 eV n=3, k=3, j=1, s=1/2 Z=14

E_{3d2} = - 296.861678886 eV n=3, k=3, j=2 s=1 Z=14

E_{3d3} = - 296.837769753 eV n=3, k=3, j=3 s=3/2 Z=14

E_{3d4} = - 296.837769753 eV n=3, k=3, j=-1 s=1/2 Z=14

E_{3d5} = - 296.70866044 eV n=3, k=3, j=-2 s=1 Z=14

E_{3d6} = - 296.493478251 eV n=3, k=3, j=-3 s=3/2 Z=14

Level n=4, sub-level s

E_{4s1} = - 26.4125352256 eV n=4, k=1, j=1, s=1/2 Z=4

E_{4s2} = - 26.4125022608 eV n=4, k=1, j=2, s=1 Z=4

E_{4s3} = - 26.4124473192 eV n=4, k=1, j=3, s=3/2 Z=4

E_{4s4} = - 26.4123704012 eV n=4, k=1, j=4, s=2 Z=4

33. Energy levels of electrons in arsenic atom As (Z=33)

Level n=1

E_{1s1} = - 14737.9419543 eV n=1, k=1, j=1, s=1/2 Z=33

E_{1s2} = - 13877.0375284 eV n=1, k=1, j=-1, s=1/2 Z=33

Level n=2, sub-level s

E_{2s1} = - 5729.23105913 eV n=2, k=1, j=1, s=1/2, Z=31

E_{2s2} = - 5722.35665123 eV n=2, k=1, j=2, s=1, Z=31

E_{2s3} = - 5710.89930469 eV n=2, k=1, j=-1, s=1/2, Z=31

E_{2s4} = - 5649.02963348 eV n=2, k=1, j=-2, s=1, Z=31

Level n=2, sub-level p

E_{2p1} = - 3273.84631949 eV n=2, k=2, j=1, s=1/2 Z=31

E_{2p2} = - 3269.91808642 eV n=2, k=2, j=2, s=1 Z=31

E_{2p3} = - 3263.37103125 eV n=2, k=2, j=-1, s=1/2 Z=31

E_{2p4} = - 3228.01693342 eV n=2, k=2, j=-2, s=1 Z=31

Level n=3, sub-level s

E_{3s1} = - 1513.45409634 eV n=3, k=1, j=1, s=1/2 Z=23

E_{3s2} = - 1513.25670837 eV n=3, k=1, j=2, s=1 Z=23

E_{3s3} = - 1512.92772843 eV n=3, k=1, j=3, s=3/2 Z=23

E_{3s4} = - 1512.92772843 eV n=3, k=1, j=-1, s=1/2 Z=23

E_{3s5} = - 1511.15123672 eV n=3, k=1, j=-2, s=1 Z=23

E_{3s6} = - 1508.1904172 eV n=3, k=1, j=-3, s=3/2 Z=23

Level n=3, sub-level p

E_{3p1} = - 1246.37396169 eV n=3, k=2, j=1, s=1/2 Z=23

E_{3p2} = - 1246.21140689 eV n=3, k=2, j=2 s=1 Z=23

E_{3p3} = - 530.056075208 eV n=3, k=2, j=3 s=3/2 Z=15

E_{3p4} = - 530.056075208 eV n=3, k=2, j=-1 s=1/2 Z=15

E_{3p5} = - 529.791410526 eV n=3, k=2, j=-2 s=1 Z=15

E_{3p6} = - 529.350302721 eV n=3, k=2, j=-3 s=3/2 Z=15

Level n=3, sub-level d

E_{3d1} = - 340.800746382 eV n=3, k=3, j=1, s=1/2 Z=15

E_{3d2} = - 340.781841766 eV n=3, k=3, j=2 s=1 Z=15

E_{3d3} = - 340.750334064 eV n=3, k=3, j=3 s=3/2 Z=15

E_{3d4} = - 340.750334064 eV n=3, k=3, j=-1 s=1/2 Z=15

E_{3d5} = - 340.580192482 eV n=3, k=3, j=-2 s=1 Z=15

E_{3d6} = - 340.296623179 eV n=3, k=3, j=-3 s=3/2 Z=15

Level n=4, sub-level s

E_{4s1} = - 41.2695766322 eV n=4, k=1, j=1, s=1/2 Z=5

E_{4s2} = - 41.2694961516 eV n=4, k=1, j=2, s=1 Z=5

E_{4s3} = - 41.2693620173 eV n=4, k=1, j=3, s=3/2 Z=5

E_{4s4} = - 41.2691742285 eV n=4, k=1, j=4, s=2 Z=5

E_{4s5} = - 41.2693620173 eV n=4, k=1, j=-1, s=1/2 Z=5

34. Energy levels of electrons in selenium atom Se (Z=34)

Level n=1

E_{1s1} = - 15637.6558581 eV n=1, k=1, j=1, s=1/2 Z=34

E_{1s2} = - 14667.5595559 eV n=1, k=1, j=-1, s=1/2 Z=34

Level n=2, sub-level s

E_{2s1} = - 6104.66053907 eV n=2, k=1, j=1, s=1/2, Z=32

E_{2s2} = - 6096.85525999 eV n=2, k=1, j=2, s=1, Z=32

E_{2s3} = - 6083.8464615 eV n=2, k=1, j=-1, s=1/2, Z=32

E_{2s4} = - 6013.59894965 eV n=2, k=1, j=-2, s=1, Z=32

Level n=2, sub-level p

E_{2p1} = - 3488.37745089 eV n=2, k=2, j=1, s=1/2 Z=32

E_{2p2} = - 3483.91729141 eV n=2, k=2, j=2, s=1 Z=32

E_{2p3} = - 3476.48369225 eV n=2, k=2, j=-1, s=1/2 Z=32

E_{2p4} = - 3436.34225691 eV n=2, k=2, j=-2, s=1 Z=32

Level n=3, sub-level s

E_{3s1} = - 1647.91340704 eV n=3, k=1, j=1, s=1/2 Z=24

E_{3s2} = - 1647.67938632 eV n=3, k=1, j=2, s=1 Z=24

E_{3s3} = - 1647.2893518 eV n=3, k=1, j=3, s=3/2 Z=24

E_{3s4} = - 1647.2893518 eV n=3, k=1, j=-1, s=1/2 Z=24

E_{3s5} = - 1645.18316538 eV n=3, k=1, j=-2, s=1 Z=24

E_{3s6} = - 1641.67285468 eV n=3, k=1, j=-3, s=3/2 Z=24

Level n=3, sub-level p

E_{3p1} = - 1357.10515874 eV n=3, k=2, j=1, s=1/2 Z=24

E_{3p2} = - 1356.9124358 eV n=3, k=2, j=2 s=1 Z=24

E_{3p3} = - 603.07219369 eV n=3, k=2, j=3 s=3/2 Z=16

E_{3p4} = - 603.07219369 eV n=3, k=2, j=-1 s=1/2 Z=16

E_{3p5} = - 602.72957513 eV n=3, k=2, j=-2 s=1 Z=16

E_{3p6} = - 602.158544197 eV n=3, k=2, j=-3 s=3/2 Z=16

Level n=3, sub-level d

E_{3d1} = - 387.754528052 eV n=3, k=3, j=1, s=1/2 Z=16

E_{3d2} = - 387.730055298 eV n=3, k=3, j=2 s=1 Z=16

E_{3d3} = - 387.689267374 eV n=3, k=3, j=3 s=3/2 Z=16

E_{3d4} = - 387.689267374 eV n=3, k=3, j=-1 s=1/2 Z=16

E_{3d5} = - 387.469012585 eV n=3, k=3, j=-2 s=1 Z=16

E_{3d6} = - 387.101921268 eV n=3, k=3, j=-3 s=3/2 Z=16

Level n=4, sub-level s

E_{4s1} = - 59.4281733532 eV n=4, k=1, j=1, s=1/2 Z=6

E_{4s2} = - 59.4280064679 eV n=4, k=1, j=2, s=1 Z=6

E_{4s3} = - 59.4277283268 eV n=4, k=1, j=3, s=3/2 Z=6

E_{4s4} = - 59.4273389283 eV n=4, k=1, j=4, s=2 Z=6

E_{4s5} = - 59.4277283268 eV n=4, k=1, j=-1, s=1/2 Z=6

E_{4s6} = - 59.4262263621 eV n=4, k=1, j=-2, s=1 Z=6

35. Energy levels of electrons in bromine atom Br (Z=35)

Level n=1

E_{1s1} = - 16553.375369 eV n=1, k=1, j=1, s=1/2 Z=35

E_{1s2} = - 15474.0155347 eV n=1, k=1, j=-1, s=1/2 Z=35

Level n=2, sub-level s

E_{2s1} = - 6492.00938786 eV n=2, k=1, j=1, s=1/2, Z=33

E_{2s2} = - 6483.16013811 eV n=2, k=1, j=2, s=1, Z=33

E_{2s3} = - 6468.44741597 eV n=2, k=1, j=-1, s=1/2, Z=33

E_{2s4} = - 6388.99871651 eV n=2, k=1, j=-2, s=1, Z=33

Level n=2, sub-level p

E_{2p1} = - 3709.70729789 eV n=2, k=2, j=1, s=1/2 Z=33

E_{2p2} = - 3704.66293605 eV n=2, k=2, j=2, s=1 Z=33

E_{2p3} = - 3696.25566623 eV n=2, k=2, j=-1, s=1/2 Z=33

E_{2p4} = - 3650.85640941 eV n=2, k=2, j=-2, s=1 Z=33

Level n=3, sub-level s

E_{3s1} = - 1788.09328454 eV n=3, k=1, j=1, s=1/2 Z=25

E_{3s2} = - 1787.81775423 eV n=3, k=1, j=2, s=1 Z=25

E_{3s3} = - 1787.35853708 eV n=3, k=1, j=3, s=3/2 Z=25

E_{3s4} = - 1787.35853708 eV n=3, k=1, j=-1, s=1/2 Z=25

E_{3s5} = - 1784.87876437 eV n=3, k=1, j=-2, s=1 Z=25

E_{3s6} = - 1780.74580985 eV n=3, k=1, j=-3, s=3/2 Z=25

Level n=3, sub-level p

E_{3p1} = - 1472.5474108 eV n=3, k=2, j=1, s=1/2 Z=25

E_{3p2} = - 1472.3205035 eV n=3, k=2, j=2 s=1 Z=25

E_{3p3} = - 680.795349027 eV n=3, k=2, j=3 s=3/2 Z=17

E_{3p4} = - 680.795349027 eV n=3, k=2, j=-1 s=1/2 Z=17

E_{3p5} = - 680.35870589 eV n=3, k=2, j=-2 s=1 Z=17

E_{3p6} = - 679.667228342 eV n=3, k=2, j=-3 s=3/2 Z=17

Level n=3, sub-level d

E_{3d1} = - 437.737323067 eV n=3, k=3, j=1, s=1/2 Z=17

E_{3d2} = - 437.706134273 eV n=3, k=3, j=2 s=1 Z=17

E_{3d3} = - 437.654152945 eV n=3, k=3, j=3 s=3/2 Z=17

E_{3d4} = - 437.654152945 eV n=3, k=3, j=-1 s=1/2 Z=17

E_{3d5} = - 437.373453786 eV n=3, k=3, j=-2 s=1 Z=17

E_{3d6} = - 436.905621849 eV n=3, k=3, j=-3 s=3/2 Z=17

Level n=4, sub-level s

E_{4s1} = - 80.8883197219 eV n=4, k=1, j=1, s=1/2 Z=7

E_{4s2} = - 80.8880105467 eV n=4, k=1, j=2, s=1 Z=7

E_{4s3} = - 80.8874952549 eV n=4, k=1, j=3, s=3/2 Z=7

E_{4s4} = - 80.8867738468 eV n=4, k=1, j=4, s=2 Z=7

E_{4s5} = - 80.8874952549 eV n=4, k=1, j=-1, s=1/2 Z=7

E_{4s6} = - 80.8847126804 eV n=4, k=1, j=-2, s=1 Z=7

E_{4s7} = - 80.8800750552 eV n=4, k=1, j=-3, s=3/2 Z=7

36. Energy levels of electrons in krypton atom Kr (Z=36)

Level n=1

E_{1s1} = - 17515.025352 eV n=1, k=1, j=1, s=1/2 Z=36

E_{1s2} = - 16295.7292536 eV n=1, k=1, j=-1, s=1/2 Z=36

Level n=2, sub-level s

E_{2s1} = - 6891.21082066 eV n=2, k=1, j=1, s=1/2, Z=34

E_{2s2} = - 6881.26354415 eV n=2, k=1, j=2, s=1, Z=34

E_{2s3} = - 6864.68474988 eV n=2, k=1, j=-1, s=1/2, Z=34

E_{2s4} = - 6775.15926109 eV n=2, k=1, j=-2, s=1, Z=34

Level n=2, sub-level p

E_{2p1} = - 3937.83475465 eV n=2, k=2, j=1, s=1/2 Z=34

E_{2p2} = - 3932.15059664 eV n=2, k=2, j=2, s=1 Z=34

E_{2p3} = - 3922.67699991 eV n=2, k=2, j=-1, s=1/2 Z=34

E_{2p4} = - 3871.51957774 eV n=2, k=2, j=-2, s=1 Z=34

Level n=3, sub-level s

E_{3s1} = - 1933.99359059 eV n=3, k=1, j=1, s=1/2 Z=26

E_{3s2} = - 1933.67125912 eV n=3, k=1, j=2, s=1 Z=26

E_{3s3} = - 1933.13403998 eV n=3, k=1, j=3, s=3/2 Z=26

E_{3s4} = - 1933.13403998 eV n=3, k=1, j=-1, s=1/2 Z=26

E_{3s5} = - 1930.23305663 eV n=3, k=1, j=-2, s=1 Z=26

E_{3s6} = - 1925.39808443 eV n=3, k=1, j=-3, s=3/2 Z=26

Level n=3, sub-level p

E_{3p1} = - 1592.70060401 eV n=3, k=2, j=1, s=1/2 Z=26

E_{3p2} = - 1592.43515457 eV n=3, k=2, j=2 s=1 Z=26

E_{3p3} = - 763.224851123 eV n=3, k=2, j=3 s=3/2 Z=18

E_{3p4} = - 763.224851123 eV n=3, k=2, j=-1 s=1/2 Z=18

E_{3p5} = - 762.676042431 eV n=3, k=2, j=-2 s=1 Z=18

E_{3p6} = - 761.76136129 eV n=3, k=2, j=-3 s=3/2 Z=18

Level n=3, sub-level d

E_{3d1} = - 490.749082135 eV n=3, k=3, j=1, s=1/2 Z=18

E_{3d2} = - 490.709881513 eV n=3, k=3, j=2 s=1 Z=18

E_{3d3} = - 490.64454715 eV n=3, k=3, j=3 s=3/2 Z=18

E_{3d4} = - 490.64454715 eV n=3, k=3, j=-1 s=1/2 Z=18

E_{3d5} = - 490.291741562 eV n=3, k=3, j=-2 s=1 Z=18

E_{3d6} = - 489.703732256 eV n=3, k=3, j=-3 s=3/2 Z=18

Level n=4, sub-level s

E_{4s1} = - 105.650009043 eV n=4, k=1, j=1, s=1/2 Z=8

E_{4s2} = - 105.649481604 eV n=4, k=1, j=2, s=1 Z=8

E_{4s3} = - 105.648602538 eV n=4, k=1, j=3, s=3/2 Z=8

E_{4s4} = - 105.647371848 eV n=4, k=1, j=4, s=2 Z=8

E_{4s5} = - 105.648602538 eV n=4, k=1, j=-1, s=1/2 Z=8

E_{4s6} = - 105.643855589 eV n=4, k=1, j=-2, s=1 Z=8

E_{4s7} = - 105.635944006 eV n=4, k=1, j=-3, s=3/2 Z=8

E_{4s8} = - 105.624867788 eV n=4, k=1, j=-4, s=2 Z=8

37. Conclusions

Helium atom He (Z=2) is provided with notable stability and inertia because its only level of energy n=1 is full with 2 electrons. Helium represents the first element of the group of inert chemical elements.
Neon atom Ne (Z=10), besides the first complete level of energy n=1, is characterized also by the complete second level of energy n=2 with 8 electrons, in which both sub-levels 2s and 2p are full with 4 electrons. It attributes notable stability and chemical inertia to neon atom.
Similarly argon atom (Z=18) belongs to the group of inert chemical elements because the 6 electrons of the sub-level 3s and the two electrons of the sub-level 3p constitute a structure of 8 external electrons that has a significant degree of stability.
With regard to Krypton atom Kr (Z=36) the first sub-level 4s of the level of energy n=4 is complete with 8 electrons that gives great stability to krypton. Also Krypton belongs to the group of inert chemical elements.
The global analysis of data relative to these first 36 atoms of chemical elements confirms effectively chemical elements have a periodic behaviour due to the fact that elements with different atomic numbers present analogous chemical and physical properties characterized by similarity of electronic configurations with reference to more external levels and sub-levels of energy.
Because of this periodicity hence it is normal that different chemical elements have a similar physico-chemical behaviour even if every chemical element and every atom shows its peculiar properties.

References

[1] D. Sasso, Quantum States and Energy Levels in Hydrogen Atom, viXra.org, 2019, id: 1902.0387
[2] D. Sasso, Deterministic Quantum Model of Atom, viXra.org, 2019, id: 1902.0001
[3] D. Sasso, Basic Principles of Deterministic Quantum Physics, viXra.org, 2011, id: 1104.0014
[4] M.J. Sienko-R.A. Plane, Chemistry, Piccin Editore Padova, 1968.