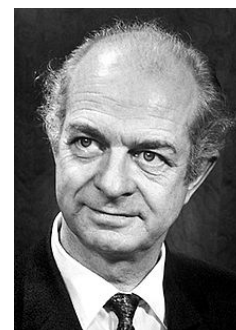


The Electronegativity is a chemical property. It describes the tendency of an atom to attract shared electron pairs towards itself. The Electronegativity of an atom is influenced by both its atomic number and distance between valence shell electrons. The Electronegativity increases in correspondence with the magnitude of attraction of electrons towards itself. Electronegativity is determined by factors like the nuclear charge and the number of electrons present in the atoms shells. The farther from the valence electrons be, less positive charge they will experience because of their increased distance from the nucleus. Presence of electrons in the inner shells also act to shield the valence electrons from the positively charged nucleus.



The opposite of electronegativity is electropositivity. It is the measure of an elements ability to give out electrons. Electronegativity has long history since the time of J.J. Berzelius and Avogadro. An accurate scale of electronegativity was developed in 1932, when Linus Pauling proposed and electronegative scale. It depends on bond energy. The electronegativity values are shown in (Fig. 4)

In general, electronegativity increases on passing from left to right across a period and decreases on descending a group.

Linus Pauling

1												18						
1	H 1s <sup>1</sup> 13.6											He 1s <sup>2</sup> 24.6						
2	Li 2s <sup>1</sup> 5.4	Be 2s <sup>2</sup> 9.3	<b>Electronegativity of the Atoms</b>										B 2s <sup>2</sup> 2p <sup>1</sup> 11.4	C 2s <sup>2</sup> 2p <sup>2</sup> 13.9	N 2s <sup>2</sup> 2p <sup>3</sup> 16.9	O 2s <sup>2</sup> 2p <sup>4</sup> 18.6	F 2s <sup>2</sup> 2p <sup>5</sup> 23.3	Ne 2s <sup>2</sup> 2p <sup>6</sup> 28.3
		Average valence electron binding energy as T → 0K eV e <sup>-1</sup>																
3	Na 3s <sup>1</sup> 5.1	Mg 3s <sup>2</sup> 7.6											Al 3s <sup>2</sup> 3p <sup>1</sup> 9.1	Si 3s <sup>2</sup> 3p <sup>2</sup> 10.8	P 3s <sup>2</sup> 3p <sup>3</sup> 12.8	S 3s <sup>2</sup> 3p <sup>4</sup> 13.6	Cl 3s <sup>2</sup> 3p <sup>5</sup> 16.3	Ar 3s <sup>2</sup> 3p <sup>6</sup> 19.1
4	K 4s <sup>1</sup> 4.3	Ca 4s <sup>2</sup> 6.1	Sc 4s <sup>2</sup> 3d <sup>1</sup> 7.0	Ti 4s <sup>2</sup> 3d <sup>2</sup> 8.4	V 4s <sup>2</sup> 3d <sup>3</sup> 9.7	Cr 4s <sup>1</sup> 3d <sup>5</sup> 8.0	Mn 4s <sup>2</sup> 3d <sup>5</sup> 12.3	Fe 4s <sup>2</sup> 3d <sup>6</sup> 10.1	Co 4s <sup>2</sup> 3d <sup>7</sup> 11.9	Ni 4s <sup>2</sup> 3d <sup>8</sup> 12.9	Cu 4s <sup>1</sup> 3d <sup>10</sup> 10.2	Zn 4s <sup>2</sup> 3d <sup>10</sup> 15.9	Ga 4s <sup>2</sup> 4p <sup>1</sup> 9.9	Ge 4s <sup>2</sup> 4p <sup>2</sup> 11.1	As 4s <sup>2</sup> 4p <sup>3</sup> 12.5	Se 4s <sup>2</sup> 4p <sup>4</sup> 13.2	Br 4s <sup>2</sup> 4p <sup>5</sup> 15.2	Kr 4s <sup>2</sup> 4p <sup>6</sup> 17.4
5	Rb 5s <sup>1</sup> 4.2	Sr 5s <sup>2</sup> 5.7	Y 5s <sup>2</sup> 4d <sup>1</sup> 6.3	Zr 5s <sup>2</sup> 4d <sup>2</sup> 7.5	Nb 5s <sup>1</sup> 4d <sup>4</sup> 7.0	Mo 5s <sup>1</sup> 4d <sup>5</sup> 8.3	Tc 5s <sup>2</sup> 4d <sup>5</sup> 10.9	Ru 5s <sup>1</sup> 4d <sup>6</sup> 8.4	Rh 5s <sup>1</sup> 4d <sup>7</sup> 9.3	Pd 4d <sup>10</sup> 8.3	Ag 5s <sup>1</sup> 4d <sup>10</sup> 12.0	Cd 5s <sup>2</sup> 4d <sup>10</sup> 16.1	In 5s <sup>2</sup> 5p <sup>1</sup> 9.3	Sn 5s <sup>2</sup> 5p <sup>2</sup> 10.2	Sb 5s <sup>2</sup> 5p <sup>3</sup> 11.2	Te 5s <sup>2</sup> 5p <sup>4</sup> 12.0	I 5s <sup>2</sup> 5p <sup>5</sup> 13.4	Xe 5s <sup>2</sup> 5p <sup>6</sup> 14.9
6	Cs 6s <sup>1</sup> 3.9	Ba 6s <sup>2</sup> 5.2	Lu 6s <sup>2</sup> 5d <sup>1</sup> 6.4	Hf 6s <sup>2</sup> 5d <sup>2</sup> 7.1	Ta 6s <sup>2</sup> 5d <sup>3</sup> 7.8	W 6s <sup>2</sup> 5d <sup>4</sup> 8.6	Re 6s <sup>2</sup> 5d <sup>5</sup> 9.1	Os 6s <sup>2</sup> 5d <sup>6</sup> 9.2	Ir 6s <sup>2</sup> 5d <sup>7</sup> 10.8	Pt 6s <sup>1</sup> 5d <sup>9</sup> 9.5	Au 6s <sup>1</sup> 5d <sup>10</sup> 10.9	Hg 6s <sup>2</sup> 5d <sup>10</sup> 14.1	Tl 6s <sup>2</sup> 6p <sup>1</sup> 10.2	Pb 6s <sup>2</sup> 6p <sup>2</sup> 11.0	Bi 6s <sup>2</sup> 6p <sup>3</sup> 10.7	Po 6s <sup>2</sup> 6p <sup>4</sup> 12.2	At 6s <sup>2</sup> 6p <sup>5</sup> 12.6	Rn 6s <sup>2</sup> 6p <sup>6</sup> 14.6
7	Fr 7s <sup>1</sup> 4.1	Ra 7s <sup>2</sup> 5.3																
6	La 6s <sup>2</sup> 5d <sup>1</sup> 6.0	Ce 6s <sup>2</sup> 4f <sup>1</sup> 5d <sup>1</sup> 7.3	Pr 6s <sup>2</sup> 4f <sup>3</sup> 6.7	Nd 6s <sup>2</sup> 4f <sup>4</sup> 7.2	Pm 6s <sup>2</sup> 4f <sup>5</sup> 7.4	Sm 6s <sup>2</sup> 4f <sup>6</sup> 8.3	Eu 6s <sup>2</sup> 4f <sup>7</sup> 9.4	Gd 6s <sup>2</sup> 4f <sup>7</sup> 5d <sup>1</sup> 13.8	Tb 6s <sup>2</sup> 4f <sup>9</sup> 7.7	Dy 6s <sup>2</sup> 4f <sup>10</sup> 8.4	Ho 6s <sup>2</sup> 4f <sup>11</sup> 8.3	Er 6s <sup>2</sup> 4f <sup>12</sup> 7.6	Tm 6s <sup>2</sup> 4f <sup>13</sup> 9.0	Yb 6s <sup>2</sup> 4f <sup>14</sup> 10.2	<b>Element</b> ground state valence configuration $\chi$			
7	Ac 7s <sup>2</sup> 6d <sup>1</sup> 5.8	Th 7s <sup>2</sup> 6d <sup>2</sup> 6.4	Pa 7s <sup>2</sup> 5f <sup>2</sup> 6d <sup>1</sup> 6.3	U 7s <sup>2</sup> 5f <sup>3</sup> 6d <sup>1</sup> 7.5	Np 7s <sup>2</sup> 5f <sup>4</sup> 6d <sup>1</sup> 8.2	Pu 7s <sup>2</sup> 5f <sup>6</sup> 7.3	Am 7s <sup>2</sup> 5f <sup>7</sup> 8.3	Cm 7s <sup>2</sup> 5f <sup>7</sup> 6d <sup>1</sup> 10.9										

(Table. 3)

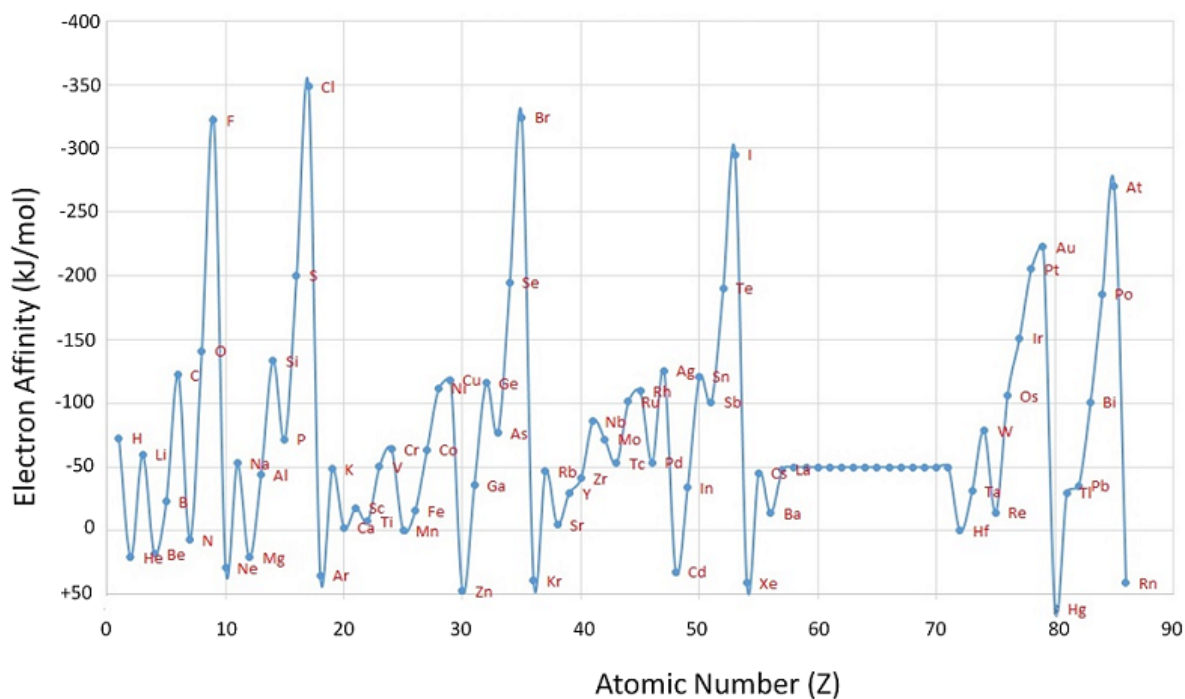
Fluorine is the most electronegative element and Caesium is least electronegative. This means Caesium fluoride is the compound whose bonding features represent the most ionic character.

### Electron Affinity

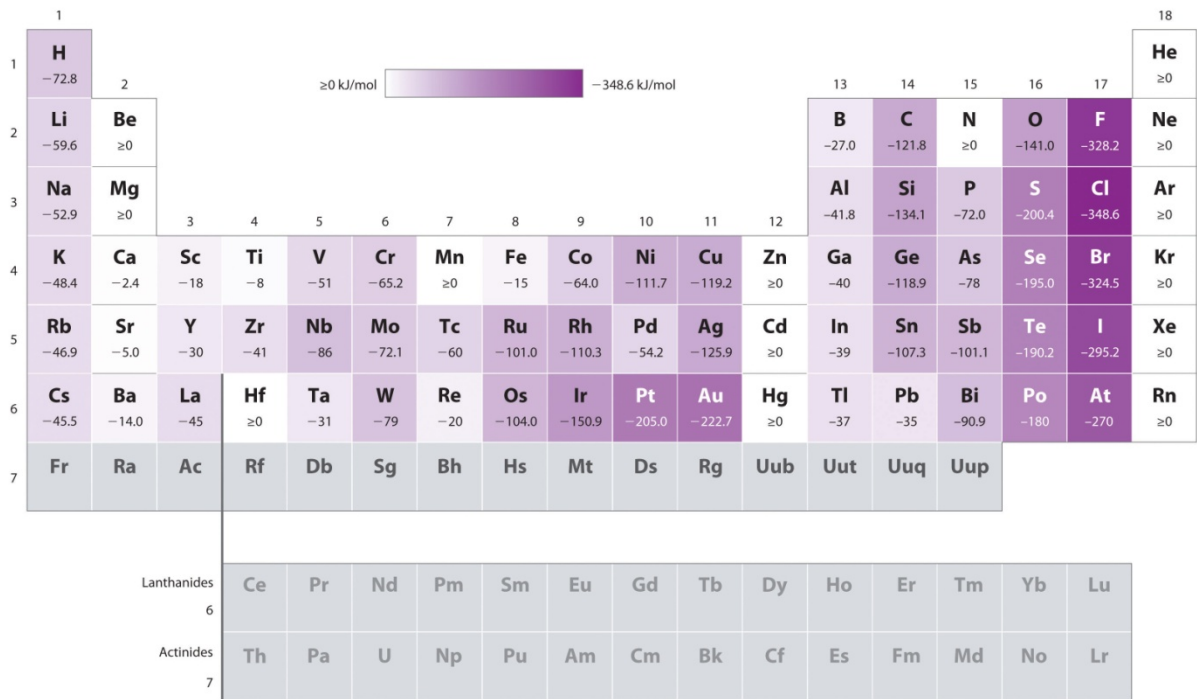
Electron affinity (EA) of an element is the change in energy that takes place when an electron is added to a gaseous atom. It is expressed in two different ways. (1) The energy that is released by adding an electron to an isolated gaseous atom, (2) the second or the

reverse method that the electron affinity is the energy required to remove an electron from a single charged anion. It may be recollected that ionisation deals with the absorption of energy in the process of formation of the positively charged ion. In a similar manner electron affinities are the negative ion equivalent.

Electron capture by an atom requires energy as the electron has to overcome the force of repulsion of the electrons existing in the atom. The electron must possess enough kinetic energy to excite a resonance of the atom plus electron system. In the reverse process the release of the electron from the negatively charged ion, the energy is carried away in the form of kinetic energy of the electron. The electron affinity values of the elements of the periodic table are shown in (fig. 4) and (Fig. 5) given below.

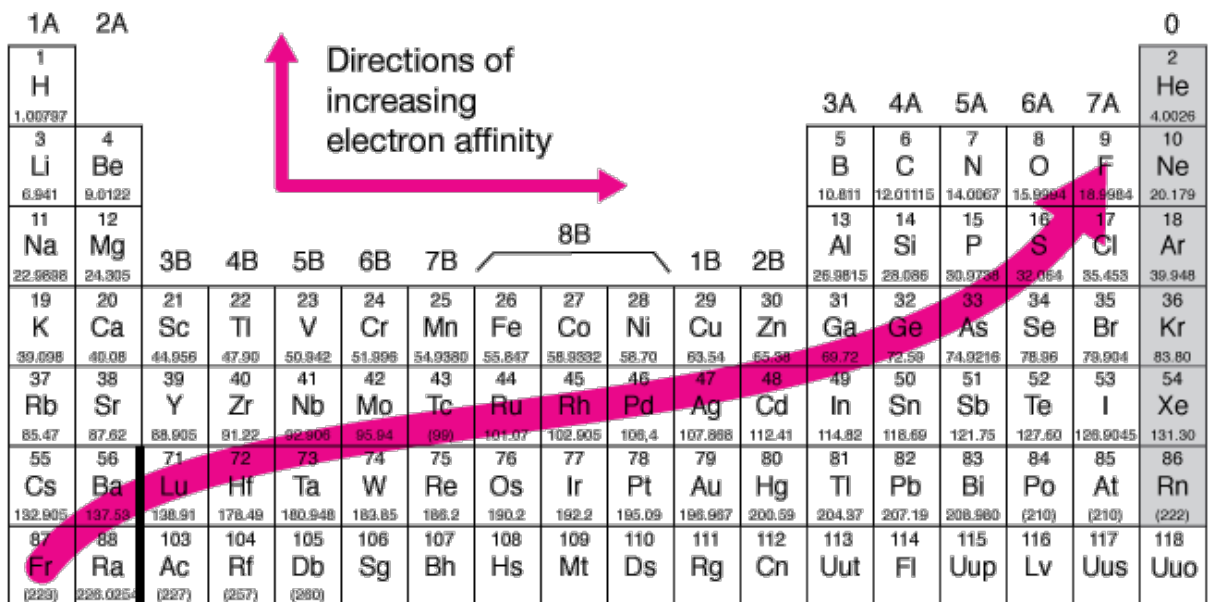


(Fig. 4)



(Fig. 5)

### Electron Affinity (EA) Trend



(Fig. 6)

### Valence and Oxidation States

The most important chemical property of an element is its valency. Valency refers to the number of hydrogen atoms that can combine with one atom of another element or twice the number of oxygen atoms. Instead of combination the phenomenon of displacement can be considered to define the valency of an element in the same way as combination. In binary ionic compounds the sum of the positive charges and negative charges is zero, thus in

calcium bromide  $\text{CaBr}_2$ , the charge of calcium is +2 and the charge of two bromine atoms is -2. Their sum is zero.

### Oxidation State

Complex chemical species which possess formula involving more than two elements and number of atoms of different elements are more than one is frequently encountered in chemistry. In order to write their formula correctly it has been useful to define a useful concept 'Oxidation state' of each element present in the molecule or ion. It is an arbitrary electric charge assigned to the atom following some simple rules.

In binary compounds the valency and oxidation state are same. Calcium chloride  $\text{CaCl}_2$  is an ionic compound. It can be written as  $\text{Ca}^{2+}(\text{Cl})_2$ . It shows the ionic nature of the compound. Calcium ion has charge +2 and its oxidation state is +II (Usually Roman letters are used to indicate oxidation state). Chloride ion has charge -1 and its oxidation state -I.

In non-ionic compounds electrons involve may not be completely transferred as in case of ionic compounds. For assigning oxidation states it is formally assumed that complete transfer of electron(s) occurs. For homonuclear molecules like  $\text{H}_2$ ,  $\text{O}_2$  and  $\text{N}_2$  the atoms are in the state their respective elements. The oxidation state of atoms in elementary state is taken as zero. In heteronuclear molecules the more electronegative element is assumed to strip off the electron from the more electropositive element. For example, in  $\text{H}_2\text{O}$ , oxygen is more electronegative than hydrogen. So its oxidation state is -II. In sulphur dioxide oxygen is more electronegative than sulphur. So oxidation state of sulphur is +IV and oxygen is -II.

The following simple principle is useful to determine the oxidation states of an element in a compound or ion.

- (1) Oxidation state of hydrogen in most of its compounds is +I except in ionic hydrides where it is -I
- (2) Oxidation state of oxygen in most of its compounds is -II except in peroxides where it is -I
- (3) The oxidation of atoms or elements in elementary state is zero.
- (4) The oxidation state of an element in a molecule or ion is calculated with reference to hydrogen or oxygen when hydrogen or oxygen combines with the element to form a binary compound.
- (5) The algebraic sum of the oxidation state of a neutral compound is zero.
- (6) The algebraic sum of the positive or negative oxidation state is equal to the total positive or negative charge of the ion in case of an ion.

Some examples are given below as illustrations.

- (1) Helium hydride  $\text{HeH}$  is the first chemical compound formed in the universe. Here He has oxidation state +I and hydrogen has oxidation state -I.
- (2) The oxide of potassium  $\text{KO}_2$  is a super oxide where potassium has oxidation

state +I and oxygen has oxidation state -1/2

- (3) F<sub>2</sub>O is a rare compound where oxidation state fluorine is -I and oxygen is +II.
- (4) For chlorate ion (ClO<sub>3</sub><sup>-</sup>) chlorine has oxidation state +V and three oxygen atoms together have oxidation state -VI and total charge is -1

The oxidation states of the elements of the periodic table are shown in (table. 4)

**Periodic Table of the Elements**

Atomic Number    Oxidation States  
Symbol  
Name    Atomic Mass

\*Oxidation States in Bold are most common. States in *italics* are predicted.

1 1A 1 <b>H</b> Hydrogen 1.008	2 2A 4 <b>He</b> Helium 4.003	3 1A 3 <b>Li</b> Lithium 6.941	4 2A 9 <b>Be</b> Beryllium 9.012	5 3A 5 <b>B</b> Boron 10.811	6 4A 6 <b>C</b> Carbon 12.011	7 5A 7 <b>N</b> Nitrogen 14.007	8 6A 8 <b>O</b> Oxygen 15.999	9 7A 9 <b>F</b> Fluorine 18.998	10 8A 10 <b>Ne</b> Neon 20.180	11 1A 11 <b>Na</b> Sodium 22.990	12 2A 12 <b>Mg</b> Magnesium 24.305	13 3A 13 <b>Al</b> Aluminum 26.982	14 4A 14 <b>Si</b> Silicon 28.086	15 5A 15 <b>P</b> Phosphorus 30.974	16 6A 16 <b>S</b> Sulfur 32.065	17 7A 17 <b>Cl</b> Chlorine 35.453	18 8A 18 <b>Ar</b> Argon 39.948	19 1A 19 <b>K</b> Potassium 39.098	20 2A 20 <b>Ca</b> Calcium 40.078	21 3B 21 <b>Sc</b> Scandium 44.956	22 4B 22 <b>Ti</b> Titanium 47.88	23 5B 23 <b>V</b> Vanadium 50.942	24 6B 24 <b>Cr</b> Chromium 51.996	25 7B 25 <b>Mn</b> Manganese 54.938	26 8 26 <b>Fe</b> Iron 55.845	27 9 27 <b>Co</b> Cobalt 58.933	28 10 28 <b>Ni</b> Nickel 58.693	29 11 29 <b>Cu</b> Copper 63.546	30 12 30 <b>Zn</b> Zinc 65.38	31 13 31 <b>Ga</b> Gallium 69.723	32 14 32 <b>Ge</b> Germanium 72.64	33 15 33 <b>As</b> Arsenic 74.922	34 16 34 <b>Se</b> Selenium 78.972	35 17 35 <b>Br</b> Bromine 79.904	36 18 36 <b>Kr</b> Krypton 83.6	37 1A 37 <b>Rb</b> Rubidium 85.468	38 2A 38 <b>Sr</b> Strontium 87.62	39 3 39 <b>Y</b> Yttrium 88.906	40 4 40 <b>Zr</b> Zirconium 91.224	41 5 41 <b>Nb</b> Niobium 92.906	42 6 42 <b>Mo</b> Molybdenum 95.94	43 7 43 <b>Tc</b> Technetium 98.906	44 8 44 <b>Ru</b> Ruthenium 101.07	45 9 45 <b>Rh</b> Rhodium 102.905	46 10 46 <b>Pd</b> Palladium 106.42	47 11 47 <b>Ag</b> Silver 107.868	48 12 48 <b>Cd</b> Cadmium 112.411	49 13 49 <b>In</b> Indium 114.818	50 14 50 <b>Sn</b> Tin 118.710	51 15 51 <b>Sb</b> Antimony 121.757	52 16 52 <b>Te</b> Tellurium 127.6	53 17 53 <b>I</b> Iodine 126.905	54 18 54 <b>Xe</b> Xenon 131.29	55 1A 55 <b>Cs</b> Cesium 132.905	56 2A 56 <b>Ba</b> Barium 137.327	57-71 3 57-71 <b>Lanthanide Series</b>	72 4 72 <b>Hf</b> Hafnium 178.49	73 5 73 <b>Ta</b> Tantalum 180.948	74 6 74 <b>W</b> Tungsten 183.84	75 7 75 <b>Re</b> Rhenium 186.207	76 8 76 <b>Os</b> Osmium 190.23	77 9 77 <b>Ir</b> Iridium 192.22	78 10 78 <b>Pt</b> Platinum 195.08	79 11 79 <b>Au</b> Gold 196.967	80 12 80 <b>Hg</b> Mercury 200.59	81 13 81 <b>Tl</b> Thallium 204.383	82 14 82 <b>Pb</b> Lead 207.2	83 15 83 <b>Bi</b> Bismuth 208.980	84 16 84 <b>Po</b> Polonium 209	85 17 85 <b>At</b> Astatine 210	86 18 86 <b>Rn</b> Radon 222	87 1A 87 <b>Fr</b> Francium 223	88 2A 88 <b>Ra</b> Radium 226	89-103 3 89-103 <b>Actinide Series</b>	104 4 104 <b>Rf</b> Rutherfordium 261	105 5 105 <b>Db</b> Dubnium 262	106 6 106 <b>Sg</b> Seaborgium 263	107 7 107 <b>Bh</b> Bohrium 264	108 8 108 <b>Hs</b> Hassium 265	109 9 109 <b>Mt</b> Meitnerium 266	110 10 110 <b>Ds</b> Darmstadtium 268	111 11 111 <b>Rg</b> Roentgenium 269	112 12 112 <b>Cn</b> Copernicium 277	113 13 113 <b>Uut</b> Ununtrium 278	114 14 114 <b>Fl</b> Flerovium 285	115 15 115 <b>Uup</b> Ununpentium 286	116 16 116 <b>Lv</b> Livermorium 289	117 17 117 <b>Uus</b> Ununseptium 288	118 18 118 <b>Uuo</b> Ununoctium 286
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(Table. 4)

Oxidation states of elements range from -4(Si, C, Cr, Sn) to +8(Ru, Os). Chemical reaction between elements is an electromagnetic interaction and these oxidation states are attainable by chemical reactions.