

Ionization Energy

Definition

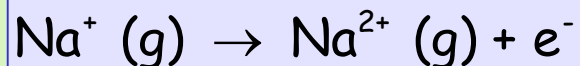
The ionization energy of an atom or ion is the minimum energy required to remove an electron from the ground state of the isolated atom or ion.

First, Second Ionization Energy

The first ionization energy (IE_1), is the energy needed to remove the first electron from a neutral atom.



The second ionization energy (IE_2), is the energy needed to remove the second electron. The greater the ionization energy, the more difficult it is to remove an electron.



Ionization Energy

Ionization energies

The ionization energies for an element increase in magnitude as successive electrons are removed: $IE_1 < IE_2 < IE_3$, and so forth.

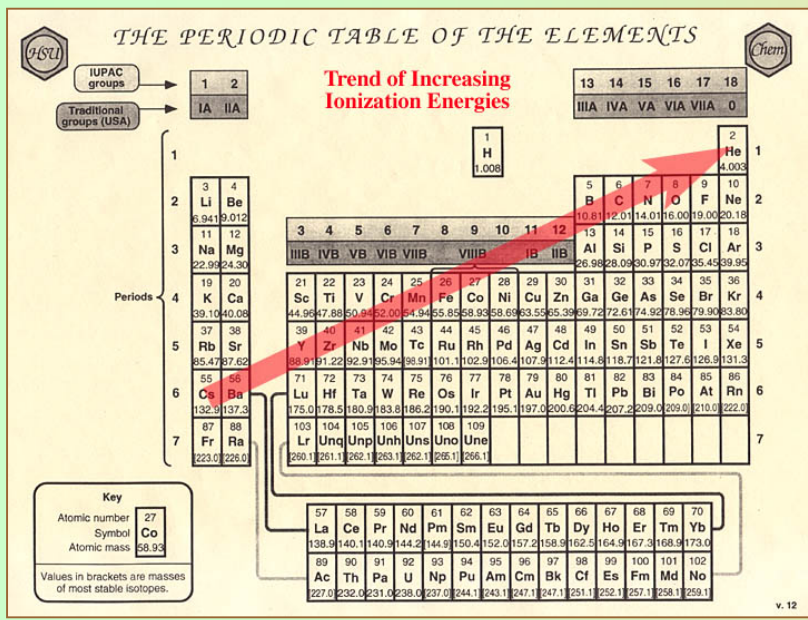
A sharp increase in ionization energies occur when an inner electron is removed (sharp increase in the effective nuclear charge, Z^*)

General increase →

Successive Ionization Energies for Period 3 Elements							
Element	IE ₁	IE ₂	IE ₃	IE ₄	IE ₅	IE ₆	IE ₇
Na	498	4560	6910	9540	13 400	16 600	20 100
Mg	736	1445	7730	10 600	13 600	18 000	21 700
Al	577	1815	2740	11 600	15 000	18 310	23 290
Si	787	1575	3220	4350	16 100	19 800	23 800
P	1063	1890	2905	4950	6270	21 200	25 400
S	1000	2260	3375	4565	6950	8490	27 000
Cl	1255	2295	3850	5160	6560	9360	11 000
Ar	1519	2665	3945	5770	7230	8780	12 000

General decrease ↓

Ionization Energy

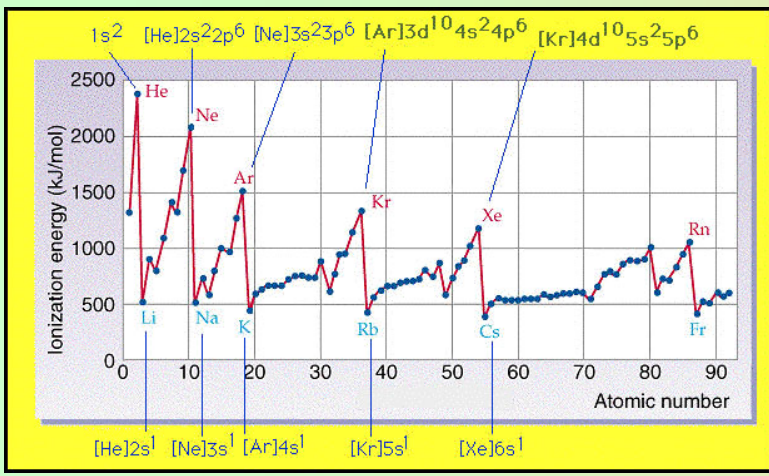


Periodic Trends in Ionization Energies

Within each row, IE_1 generally increases with increasing atomic number. The alkali metals show the lowest ionization energy in each period, and the noble gases the highest.

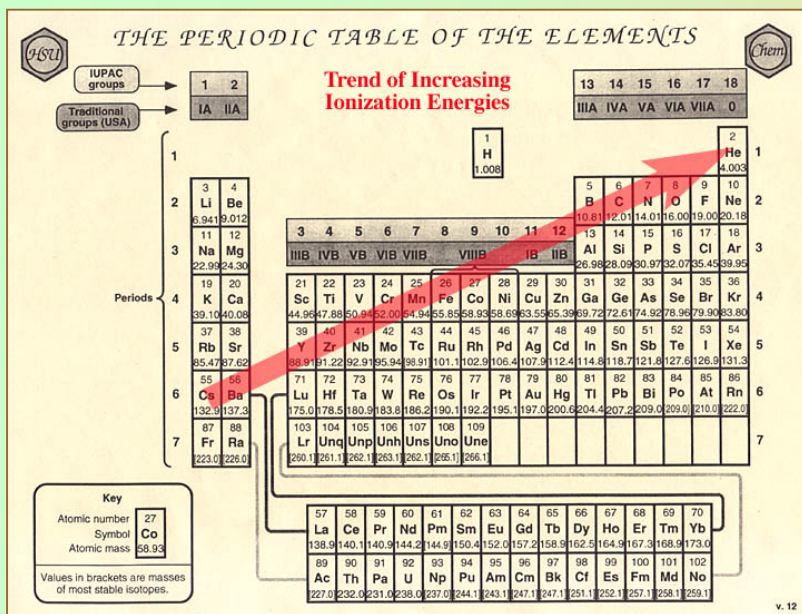
As we move across a period, there is both an increase in effective nuclear charge and a decrease in atomic radius, causing the ionization energy to increase.

http://www.humboldt.edu/~rap1/ChemSupp/HSU-PT/HSU_PerTab_Y_IE.jpg



<http://www.iun.edu/~cpanhd/C101webnotes/modern-atomic-theory/images/ionization-energy.jpg>

Ionization Energy



Periodic Trends in Ionization Energies

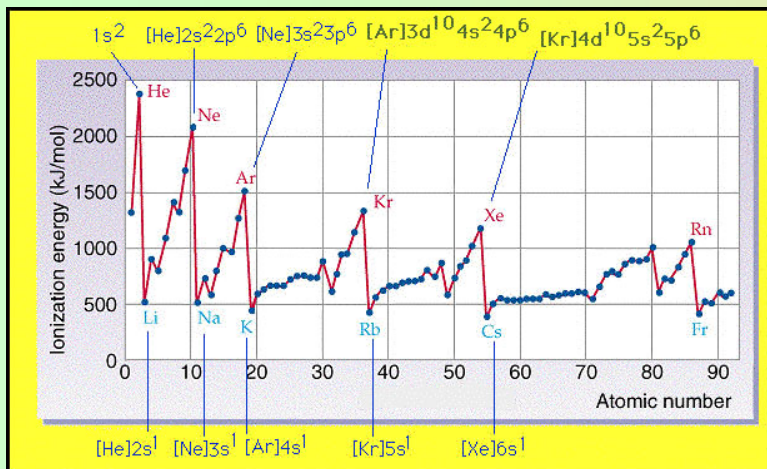
Within each group, the ionization energy generally increases with decreasing the atomic number. For example, the first ionization energies of the noble gases follow the order:



http://www.humboldt.edu/~rap1/ChemSupp/HSU-PT/HSU_PerTab_Y_IE.jpg

As we move down a column, the atomic radius increases, while the effective nuclear charge remains essentially constant.

Thus, the ionization energy decreases from top to down.



<http://www.iun.edu/~cpanhd/C101webnotes/modern-atomic-theory/images/ionization-energy.jpg>

Ionization Energy

Some irregularities

The irregularities between a row (N-O, ...) are due to the differences in energy between "s" and "p" orbitals, and the additional stability of p^3 configurations

