

Worked exercise Topic 1

In the following table the n^{th} successive ionization energies of several elements are collected. Look at them and answer the following questions:

Element	Ionization Energy (kJ/mol)				
	1 st	2 nd	3 rd	4 th	5 th
D	630	1230	2390	7090	8840
L	590	1150	4900	6470	8140
M	650	1590	2980	4740	6690
Q	500	4560	6900	9540	13300
R	550	1060	4210	5500	6910

Which two elements of the following pairs belong to the same group? Why?

1) D and L 2) M and Q 3) D and Q 4) L and R 5) M and R

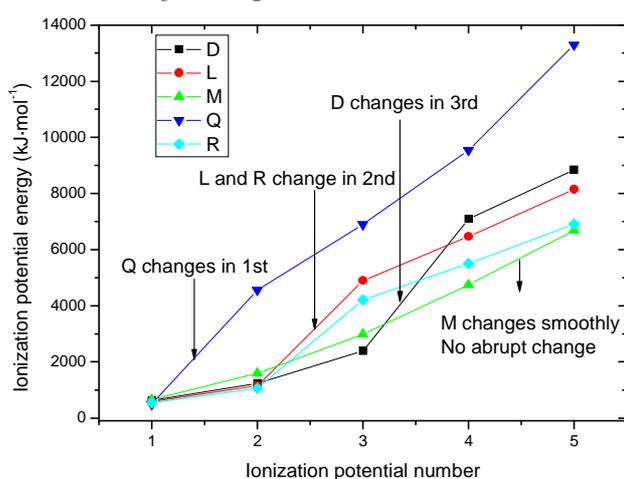
What of the following chloride derivatives are correct? Why?

1) QCl_2 2) RCl_2 3) LCl_3 4) DCl_4 5) QCl

Solution:

You all should know what Ionization Potential is. As we explained in class, if we take an electron from an atom that has a filled or half-filled valence shell this requires a great energy because the initial configuration is very stable. On the other hand, if arrive to a filled or half-filled valence shell after, lets us say, n successive ionizations, then the $(n+1)$ th ionization will require a great amount of energy. This means that the trend followed by previous ionizations will change abruptly.

So to discover when we arrive to a very stable configuration we must investigate the trends. This can be done by inspection of the above table or, perhaps better, if we plot the data in a joint figure as done below.



If you look at the figure, you will discover that:

- The first ionization of Q is similar to all elements but the second ionization requires high energy. That means that the electronic configuration after the first ionization is very stable. Therefore, the ion Q^+ is stable.

- L and R present an abrupt change after the second ionization. That means that the electronic configurations after the second ionization are very stable. So ions

L^{2+} and R^{2+} are stable

- D reaches a stable configuration after the third ionization. That means that the electronic configuration after the third ionization is stable. So ion D^{3+} is stable

- M presents a continuous increase in ionization up to the fifth one and we can not extract any information about its stability.

Which two elements of the following pairs belong to the same group? Why?

- 1) D and L 2) M and Q 3) D and Q 4) L and R 5) M and R

Obviously the correct answer is 4)

What of the following chloride derivatives are correct? Why?

- 1) QCl_2 2) RCl_2 3) LCl_3 4) DCl_4 5) QCl

Among these binary compounds, only those that formed by Q^+ , L^{2+} , R^{2+} or D^{3+} cations will be formed

Only RCl_2 and QCl meet this requirement.