IONIZATION ENERGY

Ionisation energy: The required to remove of from one mole of to produce one mole of .

The symbol used to represent ionization energy is:

The units are:

Subsequent ionization energies

The required to remove of from one mole of to produce one mole of .

Q) Why is energy required to remove an electron from an atom or ion?

There is an force of attraction between the charged nucleus and the charged electrons. This requires to overcome.

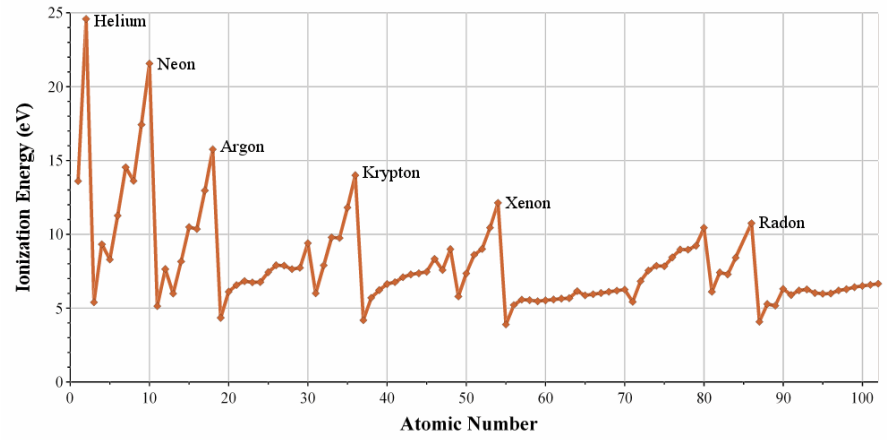
Q) Look at the successive ionization energies of Lithium. Why do you think ionization energies increase as more electrons are removed?

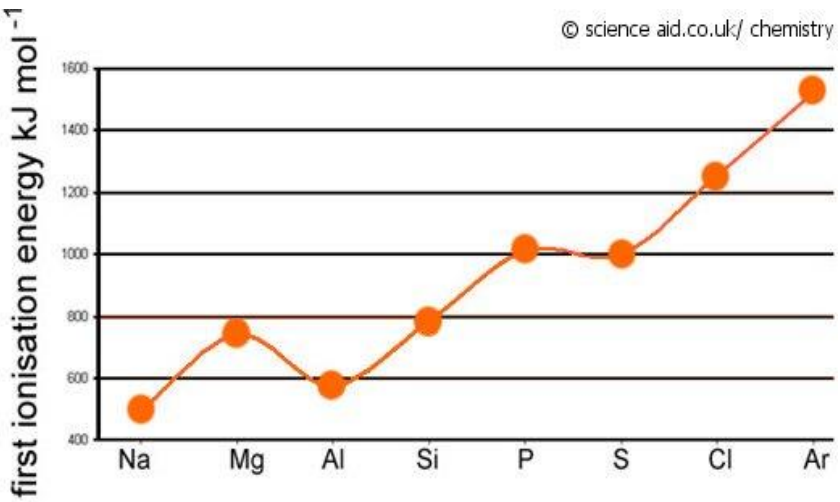
Li 1st 520 2nd 7300 3rd 11800

There are electrons in the . The (amount of) remains the . Therefore, there is a force of attraction on the remaining electrons requiring more to remove an .

Factors influencing ionization energies:

Look at the graph below what patterns do you notice?





There are three main factors that affect ionisation energy:

1. charge (the number of in a).
   Across a . The nuclear charge because one is added per element e.g.

2. radius.

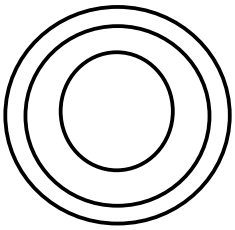
   Across a the atomic radius , because of the in nuclear charge and hence, the attraction on the .
   Down a the atomic radius because there is an in the number of . The attraction on the outer electrons .

3. effect.
   The shielding effect is to do with the number of electrons. The greater the number of inner electrons (or shells). The the shielding effect. The inner electrons create on the outer electrons and 'shield' the attraction of the . This means that an in the shielding effect the attraction on the requiring energy to remove an .
   Across a the shielding effect remains .
   Down a the shielding effect , due to an increase in the number of (inner electrons).

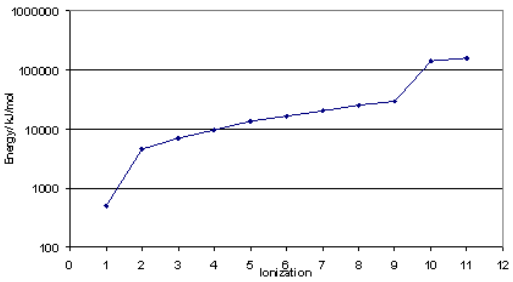
These three factors contribute to the:

Working out an unknown element from successive ionization energies

Draw a dot and cross diagram of sodium:



Look at the successive ionization energies of sodium:



What do you notice?

Look back at the electronic structure of sodium can you make any links between the graph and the structure?

A more detailed look at ionization energy values:

We have said that nuclear charge across a period. Therefore wouldn't ionisation energy increase always increase across a period? No there are some discrepancies.

Draw the **box diagram** of the electronic structure of Beryllium and Boron.

What are the 1st ionization energy values for beryllium and boron? What explanation can you give for these differences (refer to the back of the booklet)?

The outermost electron in Boron is in the energy subshell and there is slightly more from inner shell electrons meaning that energy is required to remove the electron.

Draw the electronic structure in **box diagram** of nitrogen and oxygen.

What are the 1st ionization energies for oxygen and nitrogen? Draw the electron structure box diagrams. Can you explain the ionization energy difference?

There are electrons in the 2P subshell in oxygen, this creates meaning less is required to remove the electron.

Similar patterns can be seen throughout the periodic table, e.g.

Answering questions on ionization energies:

There are four types of question that can be asked in the exam:

1. Explaining the difference in ionization energies of atoms the period.

2. Explaining the difference in ionization energies of atoms a group.

3. Explaining the in ionization energies a period.

4. Identifying an unknown element from energy data.

HINT: Always mention the three factors (for question one and two)

Across a (in general).

1) Explain why silicon has a higher 1st ionization energy than aluminium. 3marks

Silicon has a nuclear charge, a in atomic radius and shielding effect. This means there is a nuclear on the electrons. Therefore, energy is required to an electron.

Down a .

2) Explain why magnesium has a lower 1st ionization energy than beryllium. 3marks

Magnesium has a atomic radius as it has shells and therefore an in shielding effect. This offsets the in nuclear charge. This means there is nuclear on the electrons. Therefore, energy is required to an electron.

Discrepancies in I.E a period (group and group).

3a) Explain why magnesium has a higher 1st ionization energy than aluminium. 2marks

Discrepancies in I.E a period (group and group).

3b) Explain why oxygen has a lower 1st ionization energy than nitrogen. 2marks

Determining an element from ionisation energy data.

3c) Element X is in period three of the periodic table. From the successive ionisation energy data below, identify the element and explain you answer. 3 marks

I.E	Energy in $KJmol^{-1}$
1st	999.6
2nd	2252
3rd	3357
4th	4556
5th	8004.3
6th	8495.8
7th	27107
8th	31719

4a) Describe the general trend in ionisation energies from sodium to argon, in terms of atomic structure.

b) State and explain the difference in 1st ionisation energy between nitrogen and arsenic.