



Higher Chemistry: Unit 1 - Chemical Changes and Structure

Part A - Periodicity and Bonding

Lesson 4 - Periodicity: Electronegativity

Learning Outcomes

By the end of this lesson you should know:

1. What is meant by the term electronegativity.
2. The trends in electronegativity across a period and down a group.
3. Explain the trends in electronegativity going across a period and down a group

Success Criteria

You will have been successful in this lesson if you:

1. Read and learn the notes given
2. Complete the tasks given.
3. Complete Exercise 1.4 and check your answers.

There is also a further reading section to help you gain more depth of understanding for this section.

MS Teams will be monitored throughout the week by a chemistry teacher. If you need help or clarification with either the task or the content of the lesson, just ask.

Links to Prior Knowledge

You may wish to revise the following to help you understand this lesson:

- National 5 chemistry - atomic structure, protons, electrons and electron arrangement

For reference, the periodic table is given in the data booklet. Download or print a copy of the Higher Chemistry Data Booklet from MS Teams or from the SQA website -

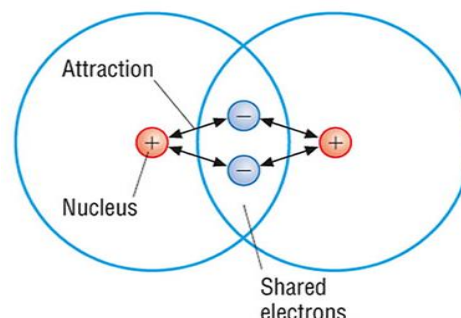
https://www.sqa.org.uk/sqa/files_ccc/ChemistryDataBooklet_NewH_AH-Sep2016.pdf

Notes

Electronegativity

It is the outer electrons in any atom which are involved in making a chemical bond with another atom. In National 5 chemistry, you would have learned that some atoms bond by sharing a pair of electrons, this is called a covalent bond and usually occurs between non-metal atoms.

The electrons in that bond are attracted to both atoms... but the strength of that attraction changes depending on the atom. Some atoms have more "pull" on the electrons than others. This is referred to as the "Electronegativity".



Definition: Electronegativity is a measure of the attraction an atom has for the electrons involved in a bond.

Electronegativity values are given page 11 of the data booklet.

Ionisation Energies and Electronegativities of Selected Elements

Notes: The first ionisation energy for an element E refers to the reaction $E(g) \rightarrow E^+(g) + e^-$; the second ionisation energy refers to $E^+(g) \rightarrow E^{2+}(g) + e^-$; etc.

Element	Symbol	Ionisation Energies/kJ mol ⁻¹				Electro-negativity (Pauling scale)
		First	Second	Third	Fourth	
hydrogen	H	1312	—	—	—	2.2
helium	He	2372	5251	—	—	—
lithium	Li	520	7298	11815	—	1.0
beryllium	Be	900	1757	14849	21007	1.5
boron	B	801	2427	3660	25026	2.0
carbon	C	1086	2353	4620	6223	2.5
nitrogen	N	1402	2856	4578	7475	3.0
oxygen	O	1314	3389	5300	7469	3.5
fluorine	F	1681	3374	6050	8408	4.0
neon	Ne	2081	3952	6122	9371	—

TASK 1 - Using the information on page 11 of the data booklet decide which atom in the following molecules would have a greater attraction the electrons in the bond.

- NH₃
- HF
- CO₂

TASK 2 - On your data booklet, find the element with the highest electronegativity and highlight this. Where does this element appear in the periodic table? Now find the element with the lowest electronegativity. Where does this element appear on the periodic table?



Electronegativity: Trends

TASK 3 - Using the information on page 11 of the data booklet find the electronegativity values for

Group 1 elements from lithium → caesium

Group 2 elements beryllium → strontium

Period 2 elements lithium → fluorine

Period 3 elements sodium → chlorine

Having gathered the data above, what general trends have you observed?

Take a moment to think about why these patterns may occur...

Trend in Periods:

Electronegativity increases as you go along a period due to an increase in nuclear charge meaning the bonding electrons are held by a stronger force.

Trend in Groups:

Electronegativity decreases as you go down a group due to the atoms having more occupied electron shells. This means:

- There is less pull on the electrons as they are increasingly further away from nuclear attraction.

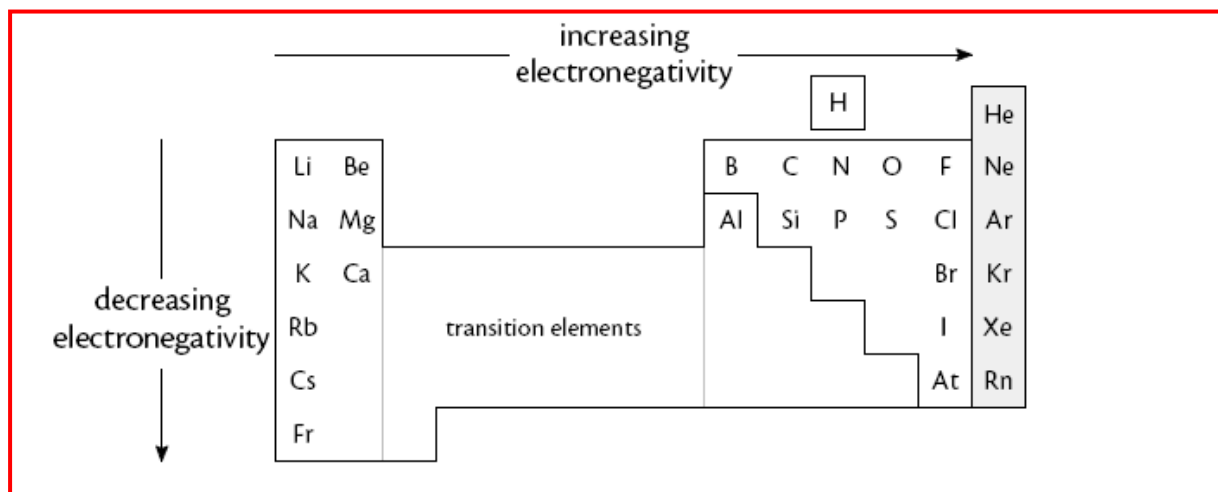
AND

- Electrons in inner shells have a screening effect shielding the bonding electrons from nuclear attraction.

Sound familiar?

The explanation of the trends in electronegativity are the same as the explanations for the trends in ionisation energy. This is because both involve the attraction of outer electrons. The stronger the "pull" on the outer electrons, the harder it will be for the electron to leave (ionisation energy). Similarly the stronger the pull on the other electrons, the stronger to pull not just on an atoms own electrons, but also on that of the other electrons in a bond.

Metals & Non-metals



Non-metals tend to have higher electronegativities than metals, because they are on the top-right of the table.

Metals tend to have lower electronegativities than non-metals, because they are on the lower-left area of the table.

SUMMARY

Electronegativity increases across a period due to increasing nuclear charge.

Electronegativity decreases down a group due to the atoms having more energy levels. This means bonding electrons are further from the nuclear charge and are shielded by inner electrons.

Learning Outcomes

You should now know:

1. Atoms of different elements have different attractions for bonding electrons.
2. Electronegativity is a measure of the attraction an atom involved in a bond has for the electrons of the bond.
3. The trends in electronegativity across periods and down groups can be rationalised in terms of covalent radius, nuclear charge and the screening effect due to inner shell electrons.



Further Reading

To learn more about electronegativity. Follow the links below:

BBC Bitesize: <https://www.bbc.co.uk/bitesize/guides/zxc99j6/revision/1>

Read page 8 and try the TEST

Evans2 chem web: <https://www.evans2chemweb.co.uk/login/index.php#>

Username: snhs password: giffnock

Select any teacher → revision material → CfE Higher → Periodicity

Royal Society of Chemistry: <http://www.rsc.org/periodic-table/trends>

Have a look at this periodic table, you can play around to see the periodicity patterns in the table.

Questions

Complete Exercise 1.4 and check your answers

**Exercise 1.4 - Periodicity: Electronegativity**

- The data book lists the electronegativity of many elements.
 - What is meant by the term electronegativity?
 - Which type of elements have the highest electronegativity?
 - Which type of elements have the lowest electronegativity?
- The table below shows the electronegativities of some group six elements:

Element	oxygen	sulfur	selenium
Electronegativity	3.5	2.5	2.0

Explain the trend in electronegativity as you go down a group in the periodic table.

- The table below shows the electronegativities of some second period elements:

Element	nitrogen	oxygen	fluorine
Electronegativity	3.0	3.5	4.0

Explain the trend in electronegativity as we cross a period in the periodic table from left to right.



Exercise 1.4 - ANSWERS

1. (a) *Electronegativity is the measure of attraction that an atom has for bonded electrons.*

(b) *Non-metals*

(c) *Metals*

2. *As you descend group 6, electronegativities decrease because: There is less pull on the electrons as they are increasingly further away from nuclear attraction.*

AND

Electrons in inner shells have a screening effect shielding the bonding electrons from nuclear attraction.

3. *Electronegativity increases as you go along a period due to an increase in nuclear charge meaning the bonding electrons are held by a stronger force.*