

3.1 ELECTRONEGATIVITY AND BONDING

Learning outcomes

Candidates should be able to:

1. define electronegativity
2. explain the factors influencing the electronegativities of the elements
3. state and explain the trends in electronegativity across a period and down a group of the Periodic Table
4. use the differences in Pauling electronegativity values to predict the formation of ionic and covalent bonds

Initial assessment

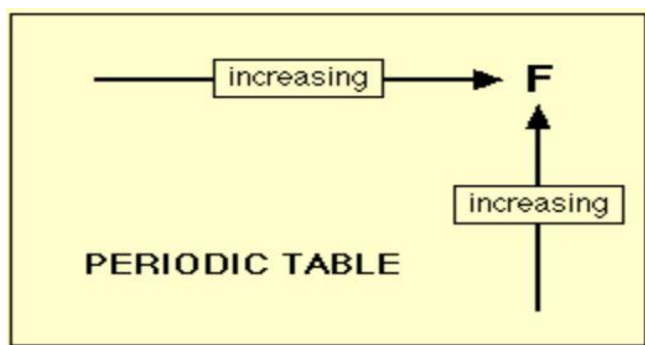
Discuss and express your previous knowledge about different kind of bonds.

Introduction

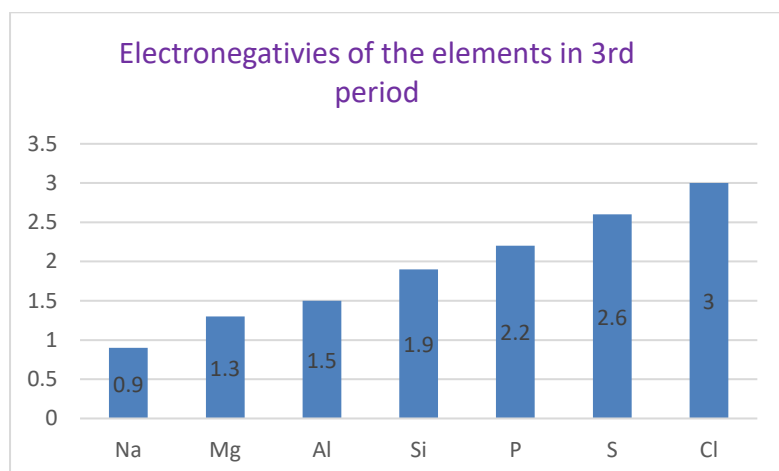
Definition

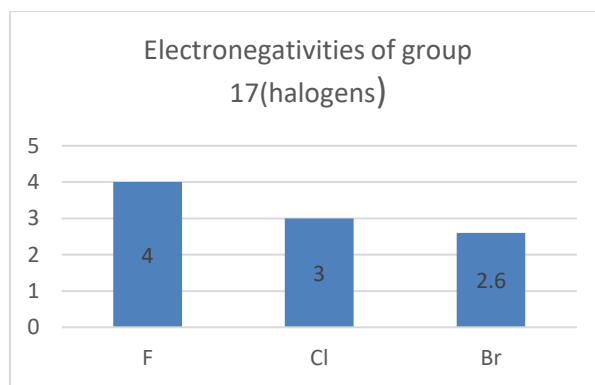
Electronegativity is **the power of an atom to attract electrons in a covalent bond to itself.**

- The greater the electronegativity value, the greater the power of an atom to attract the electrons in a covalent bond towards itself.
- For Groups 1 to 17 the pattern of electronegativity is:
Electronegativity **increases across a period**
Electronegativity **increases up each group**.



- This means that fluorine is the most electronegative element.





1. Define electronegativity.

[1]

1. Which of these elements is most electronegative?

- a. Cl b. Mg c. Br d. Na

2. Which of the following elements has electronegativity most similar to Beryllium?

- a. Boron b. Aluminium c. Silicon d. Indium

Factors influencing EN

1. Nuclear Charge: atoms in the same period with a greater (positive) nuclear charge are more likely to attract the bonding pair of electrons.
2. Atomic radius: atoms in the same group in which the outer electrons are further from the nucleus are less likely to attract the bonding pair of electrons because the pull of the positive nucleus on the electron pair is lower.
3. Shielding effect: the greater the number of inner electron shells and sub-shells, the lower the effective nuclear charge on the bonding electrons.

Ionic or covalent?

The most commonly used scale of electronegativity values is called the Pauling electronegativity scale, N_P . Following table shows some Pauling electronegativity values.

Li 1.0	Be 1.5	B 2.0	C 2.5	N 3.0	O 3.5	F 4.0
Na 0.9	Mg 1.2	Al 1.5	Si 1.8	P 2.1	S 2.5	Cl 3.0

Pauling electronegativity has no units.

Carbon ($N_P = 2.5$) and hydrogen ($N_P = 2.1$) have electronegativities that are lower than those of many other non-metallic elements

Differences in electronegativity values can be used to predict whether a simple compound has ionic or covalent bonds.

- If the electronegativity difference is high, e.g. 2.0 or more, the compound is likely to be ionic. E.g. sodium chloride: Na = 0.9, Cl = 3.0. Difference = 2.1.
- If the electronegativity difference is lower, e.g. below 1.0, the compound is likely to be covalent. E.g. methane: C = 2.5, H = 2.1. Difference = 0.4.
- A zero value shows that there is no ionic character in the bond, e.g. Cl—Cl.
- Some compounds are not entirely covalent and have some ionic character in them. These have intermediate electronegativity differences, e.g. 1.0.

2. This is a question about electronegativity.
- a) State three factors which affect the electronegativity of an element. 3
- b) Identify the element in period 4 with the highest electronegativity value. 1
- c) Explain why chlorine is more electronegative than oxygen? 2
3. The Pauling electronegativity values of elements can be used to predict the chemical properties of compounds. Use the information in the following table to answer the following questions.

element	H	Li	C	O	S
Pauling electronegativity value	2.1	1.0	2.5	3.5	2.6
first ionisation energy/kJmol ⁻¹	1310	519	1090	1310	1000
second ionisation energy/kJmol ⁻¹	—	7300	2350	3390	2260

(i) O and S are in Group 16.

Explain the difference in the Pauling electronegativity values of O and S.

[2]

4. This is a question about electronegativity.
- The electronegativities of some elements are shown in the table below.

Element	Electronegativity
Li	1.0
H	2.1
C	2.5
N	3.0
Cl	3.0

Explain why electronegativity increases across a period.

[2]

3. L and M are elements in Period 3 of the Periodic Table. Neither element is argon. Information about the Pauling electronegativity values of L and M is given.

element	Pauling electronegativity value
L	the highest of the seven elements Na to Cl
M	the lowest of the seven elements Na to Cl

Three statements about elements L and M are given.

- 1 Element L contains covalent bonds.
- 2 Element L has a higher atomic number than element M.
- 3 A compound of L and M contains ionic bonds.

Which statements are correct?

- A 1, 2 and 3 B 1 and 2 only C 1 and 3 only D 2 and 3 only

*****This is not a complete note. It is just to guide you. It is recommended to study prescribed textbooks along with this material. *****