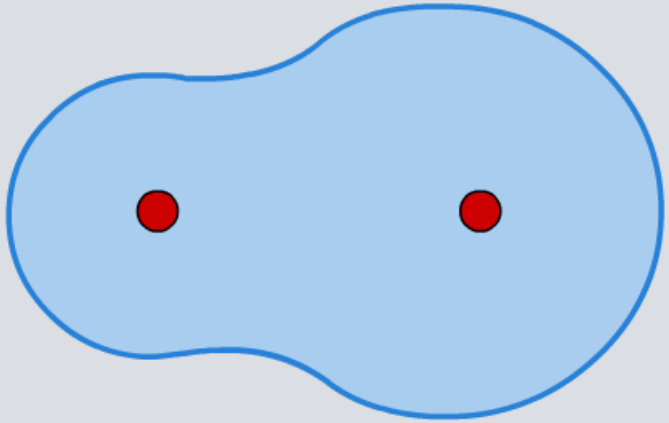
Electronegativity



What is electronegativity?

In a covalent bond between two different elements, the electron density is not shared equally.

This is because different elements have differing abilities to attract the bonding electron pair. This ability is called an element's **electronegativity**.

H 2.2						He –
Li 1.0	Be 1.6	B 2.0	C 2.6	N 3.0	O 3.4	F 4.0	Ne –
Na 0.9	Mg 1.3	Al 1.6	Si 1.9	P 2.2	S 2.6	Cl 3.2	Ar –
K 0.8						Br 3.0	Kr –

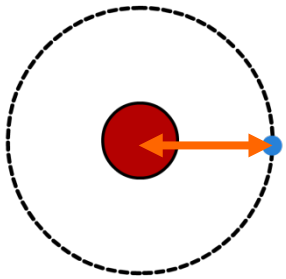
Electronegativity values for some common elements. Values given here are measured on the Pauling scale.

Electronegativity and atomic radius

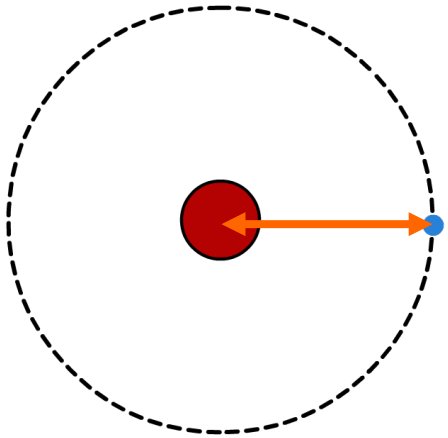
The electronegativity of an element depends on a combination of two factors:

1. **Atomic radius**

   As radius of an atom **increases**, the bonding pair of electrons become further from the nucleus. They are therefore less attracted to the positive charge of the nucleus, resulting in a **lower** electronegativity.



higher electronegativity



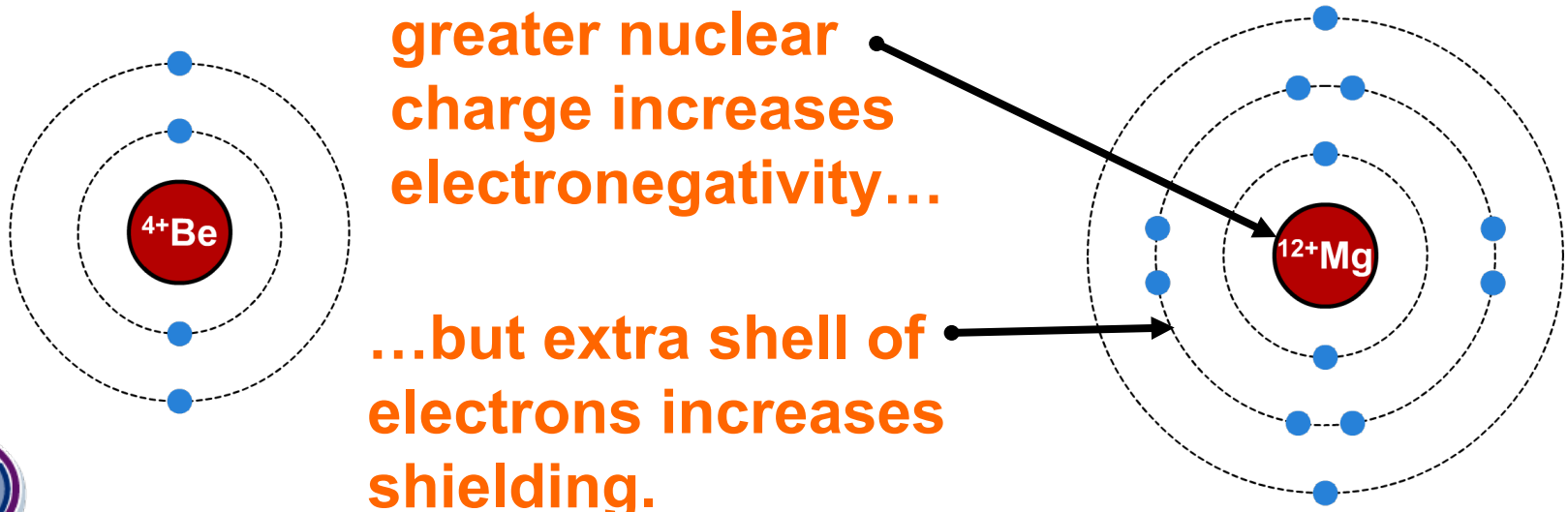
lower electronegativity

Electronegativity, protons and shielding

2. The number of unshielded protons

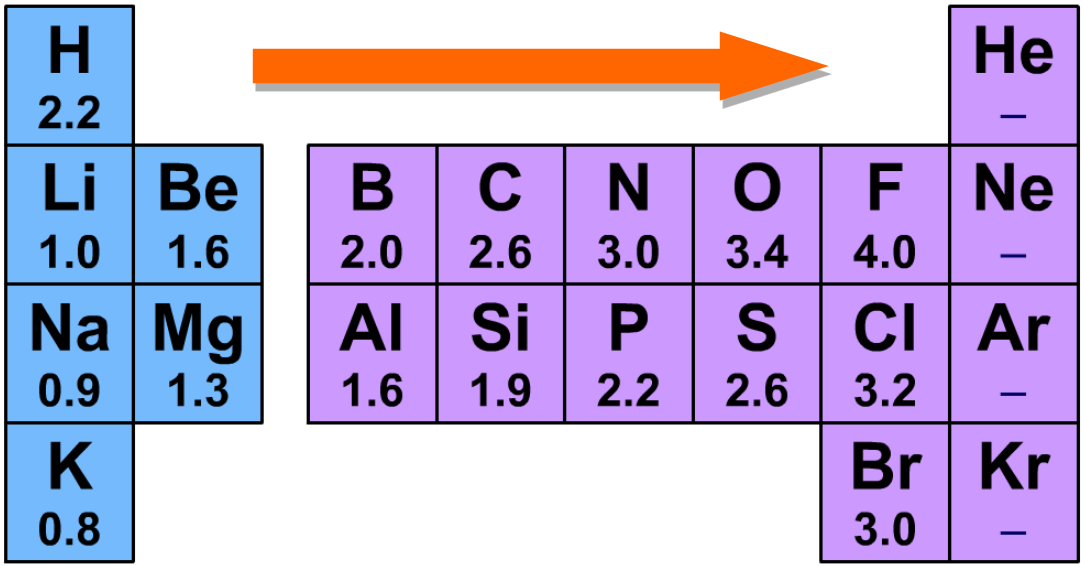
The **greater** the number of protons in a nucleus, the greater the attraction to the electrons in the covalent bond, resulting in **higher** electronegativity.

However, full energy levels of electrons **shield** the electrons in the bond from the increased attraction of the greater nuclear charge, thus **reducing** electronegativity.



Electronegativity trends: across a period

Electronegativity **increases** across a period because:

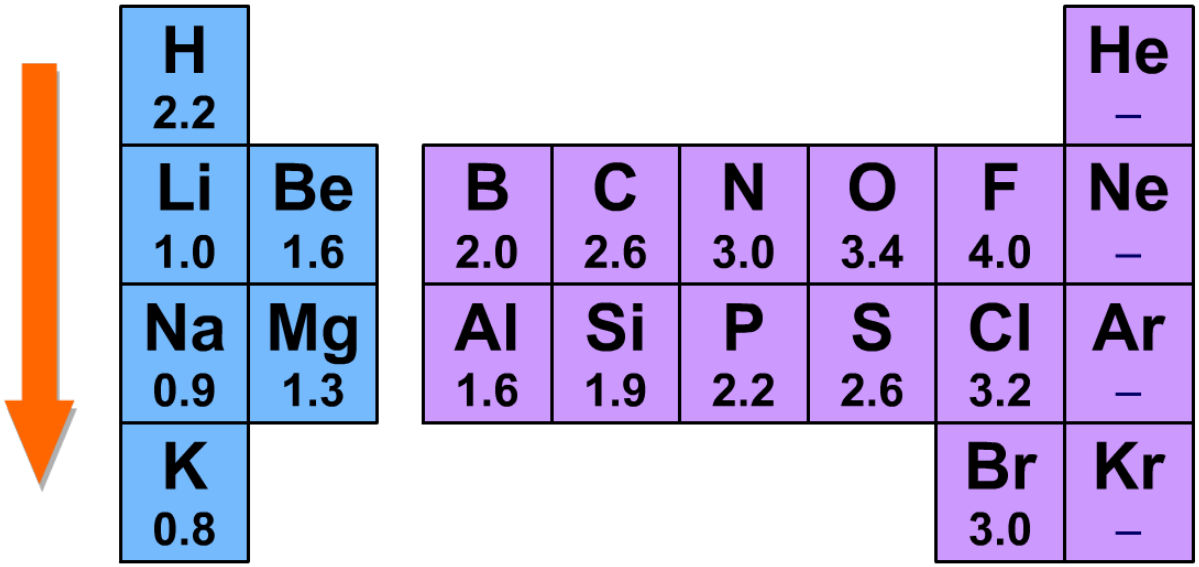


1. The atomic radius **decreases**.

2. The charge on the nucleus **increases** without significant extra shielding. New electrons do not contribute much to shielding because they are added to the same principal energy level across the period.

Electronegativity trends: down a group

Electronegativity **decreases** down a group because:



1. The atomic radius **increases**.

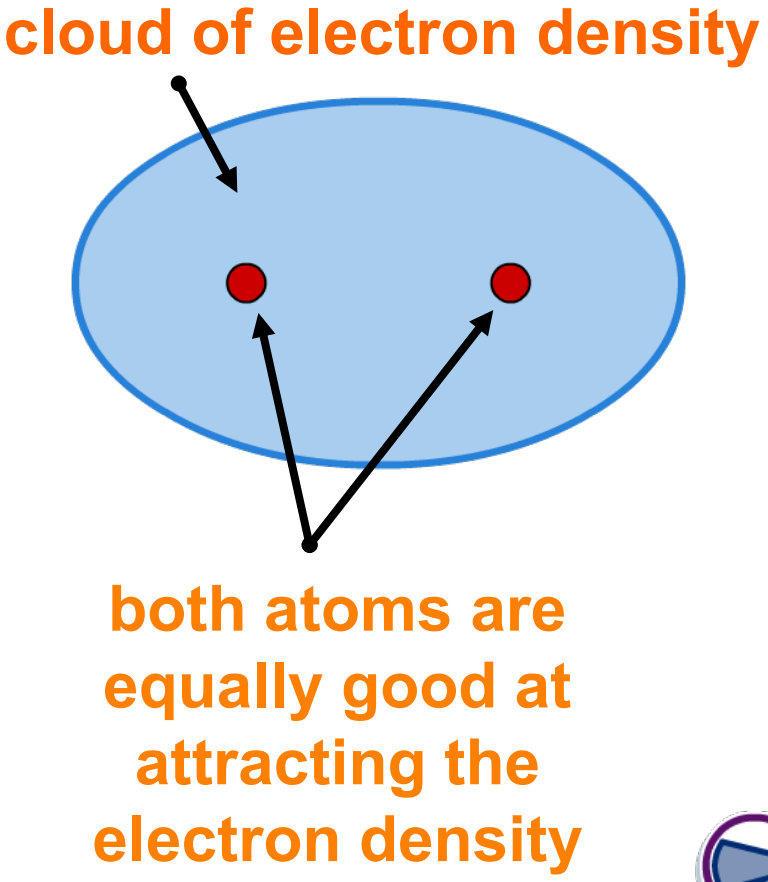
2. Although the charge on the nucleus increases, shielding also **increases** significantly. This is because electrons added down the group fill new principal energy levels.

Nonpolar bonds

If the electronegativity of both atoms in a covalent bond is identical, the electrons in the bond will be equally attracted to both of them.

This results in a symmetrical distribution of **electron density** around the two atoms.

Bonding in elements (for example O_2 or Cl_2) is always nonpolar because the electronegativity of the atoms in each molecule is the same.

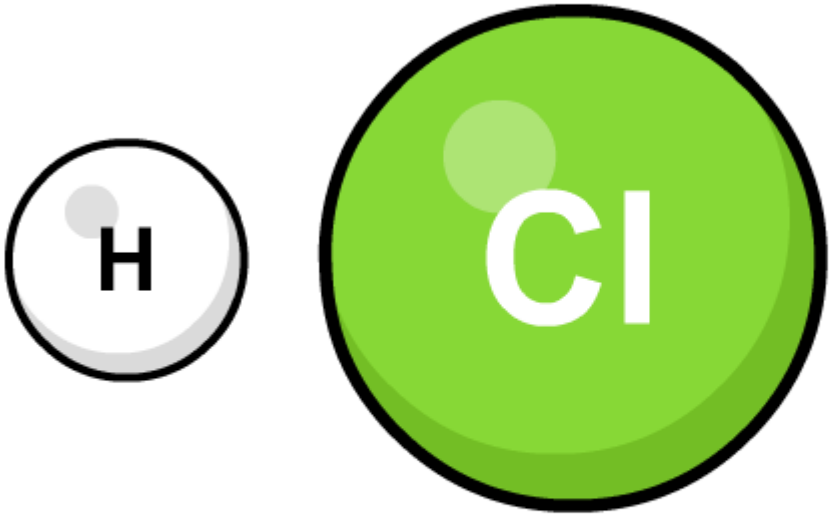


Polar bonds

Why do polar bonds occur?

When a covalent bond is formed between two different atoms a polar bond may result.

Click "**play**" or the atoms to find out why this happens.



Effect of electronegativity on polarization

The greater the electronegativity difference between the two atoms in a bond the greater the polarization of the bond.

This can be illustrated by looking at the hydrogen halides:

Element	H	F	Cl	Br	I
Pauling elecronegativities	2.2	4.0	3.2	3.0	2.7

Molecule	H–F	H–Cl	H–Br	H–I
Electronegativity difference between atoms	1.8	1.0	0.8	0.5

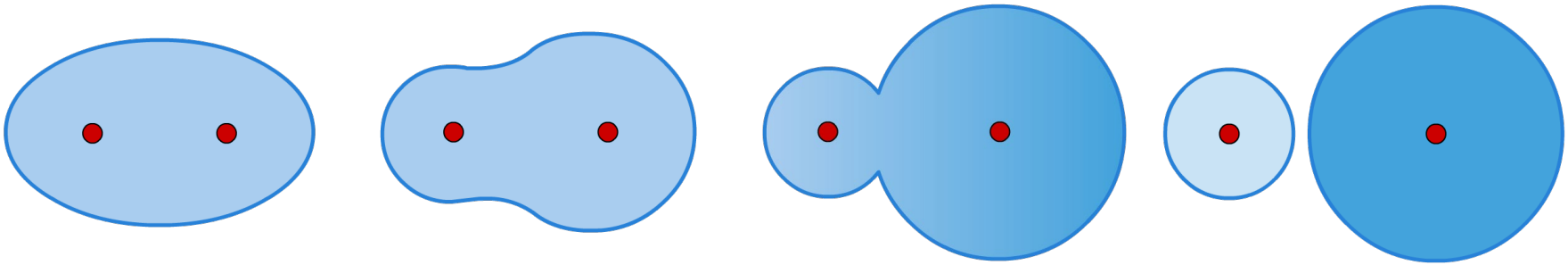
decreasing polarization

Ionic or covalent?

Rather than saying that ionic and covalent are two distinct types of bonding, it is more accurate to say that they are at the two extremes of a scale.

Less polar bonds have more **covalent character**.

More polar bonds have more **ionic character**. The more electronegative atom attracts the electrons in the bond enough to ionize the other atom.



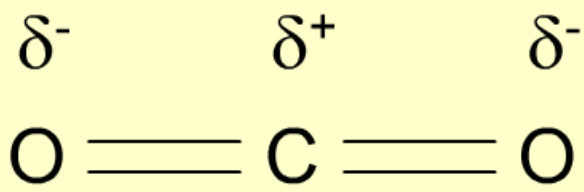
increasing polarization

Polar molecules

Molecules containing polar bonds are not always polar.

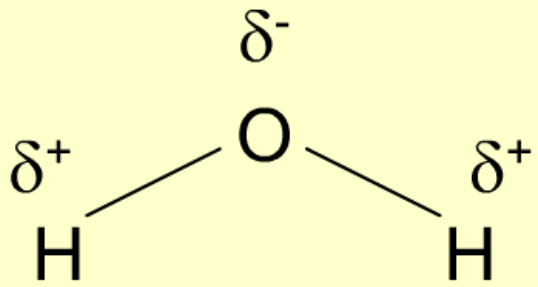
Nonpolar molecules

If the polar bonds are arranged **symmetrically**, the partial charges cancel out and the molecule is nonpolar.



Polar molecules

If the polar bonds are arranged **asymmetrically,** the partial charges do not cancel out and the molecule is polar.



Identifying polar molecules

Can you identify polar molecules?

Molecules containing an asymmetrical arrangement of polar bonds have an overall dipole.

Click "**start**" to see if you can identify polar molecules.

start