Electronegativity (EN) is the ability of an atom to attract electrons in a covalent bond. (See p.314).

Electronegativity generally increases as you go up any column in the periodic table, or go across from the left to the right.

Since the Noble gases do not usually form bonds, they are not considered here.

This is summarized in the arrow shown in the rough sketch of the periodic table below:

F is the most electronegative element, and Cs and Fr is the least.

The electronegativity of H is special. It fits in the shaded area shown above, close to the border separating metals from nonmetals.

We are generally interested in the relative electronegativity of two atoms, i.e. in knowing which atom is the most electronegative of the two. If this cannot be determined by looking at the periodic table, we can look up the actual electronegativity value (see Senese & Brady p.315 Figure 8.6).

Summary (Memorize this!):
- Electronegativity generally increases as you go up a column.
- Electronegativity generally increases as you go across from left to right.
- H is generally more electronegative than metals.
- H is generally less electronegative than nonmetals.
- Electronegativity of H and C are almost the same.

Bond Polarity
A bond is polar if the electronegativities of the two atoms are different.
The bond is described as having a dipole (2 poles: \(\delta^+\) and \(\delta^-\)).
The dipole is shown with an arrow pointing towards the \(\delta^-\). See example:

A bond is nonpolar if the electronegativity of the two atoms are the same.

Exercise: Draw in the bond dipoles of the following bonds. If there is no dipole, write NONPOLAR.

C—O N—P S—F N—N S—Br H—S Sn—H H—F C—H P—H

Molecular Polarity
The molecular polarity is determined by the sum of its bond dipoles (called the net dipole) and the geometry of the species. If the molecule is symmetrical, its bond dipoles may cancel out, the net dipole would be zero, and the species is nonpolar. If they don’t cancel out, the species is polar.

Knowing the polarity of species helps us predict both its physical and chemical properties!

The polarity of a species can be measured experimentally by the dipole moment, in units of debye (see p.313). The dipole moment of a nonpolar species is zero, and that of a polar species is greater than zero. The larger the dipole moment, the more polar the species is.
The C–O bond is polar. Why is CO₂ nonpolar?
- Work out the Lewis structure of CO₂. Review drawing Lewis structures (Sec 8.6)
- Based on the Lewis structure, work out the molecular geometry of CO₂. You should find that it’s linear. Review Chap. 9 on VSEPR, molecular geometry (Sec 9.1–9.2)
- Based on the molecular geometry of CO₂ being linear, we can see that the bond dipoles of the two C=O bonds cancel each other giving you a net dipole of zero.
Thus, CO₂ is nonpolar. Review bond polarity (Sec 8.4). Review Chap. 9 on molecular polarity (Sec 9.3)

Why is CO₂ nonpolar but SO₂ is polar?
- Work out the Lewis structures of SO₂. Don’t be lazy! Work it out.
- Now determine the molecular geometry of SO₂.
- You should find that SO₂ is bent. If you don’t remember how to do this, get help!
- Unlike CO₂ which is linear, for SO₂, the bond dipoles of the two S=O bonds will not cancel.

Thus, SO₂ is polar.

Why is CCl₄ nonpolar when the C–Cl bonds are polar?
- Once again, work out the Lewis structure and the molecular geometry.
- C–Cl bonds are indeed polar as Cl is much more electronegative than C.
- However, due to the molecular geometry being tetrahedral, the bond dipoles cancel out and there is no net dipole.

Is CH₃CH₂CH₂CH₂CH₂CH₂CH₂OH polar?
Surprising, no!

The OH bond is very polar (which allows this molecule to have H-bonding).
The CO bond is also polar. However, the rest of the molecule contains only C=C (which are nonpolar) and CH bonds (which are essentially nonpolar).
What you are seeing is a “schizophrenic” molecule. A large portion of it is a hydrocarbon which is **nonpolar** and a small portion is **polar**. The net result is it’s nonpolar.