

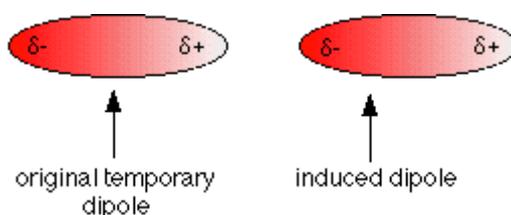
## Chemguide – answers

### VAN DER WAALS FORCES

1. a) Chlorine is more electronegative than hydrogen and so the bond between the two is polar. The chlorine end will be slightly negative, and the hydrogen end slightly positive. The molecules have permanent dipoles. The positive end of one molecule will attract the negative end of another one close to it. (You could do quite a lot of this with diagrams.)

b) The chlorine-chlorine bond is non-polar because (obviously) the atoms at either end have the same electronegativity.

c) The electrons moving around in the molecule will cause temporary fluctuating dipoles. If one end of a chlorine molecule is temporarily positive, this will induce a dipole in a nearby molecule, and these attract each other.



As long as the molecules stay close together, these fluctuating dipoles will stay synchronised with each other.

2. The increasing boiling points mean that the intermolecular attractions are getting stronger as you go down the group. These attractions are van der Waals dispersion forces, and depend on setting up temporary fluctuating dipoles. The more electrons you have in a molecule, and the longer the molecule, the bigger the dipoles that can be formed, and the stronger the attractions. As you go from fluorine to iodine, there are more and more electrons and bigger molecules.
3. The order of increasing boiling point is: (lowest) A F E D B C (highest)

The smallest molecules with the fewest electrons are A and then F. F has more electrons and is longer than A, and so can form bigger temporary dipoles., and so greater dispersion forces.

D and E both have the same number of electrons, but D is longer and so can form bigger temporary dipoles. The more rounded shape of E also means that the molecules can't get quite so close together, and so the attractions aren't as successful.

B and C are similar in size and shape, although C has more electrons because it has a chlorine atom in place of a  $\text{CH}_3$  group. The van der Waals dispersion forces will be greater because of the extra electrons moving around in C. In addition, C has a permanent dipole because of the electronegativity of the chlorine, and so there will be dipole-dipole attractions as well as the dispersion forces.