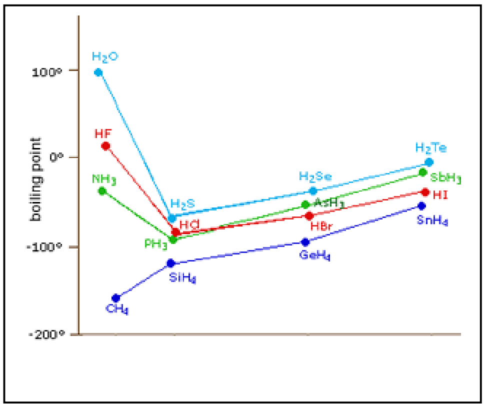
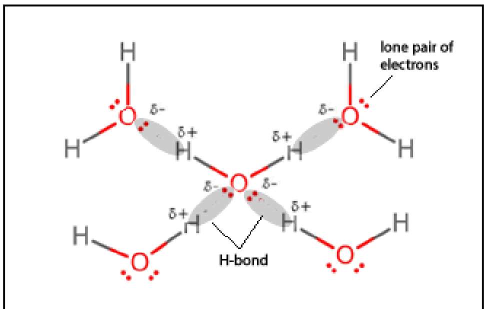
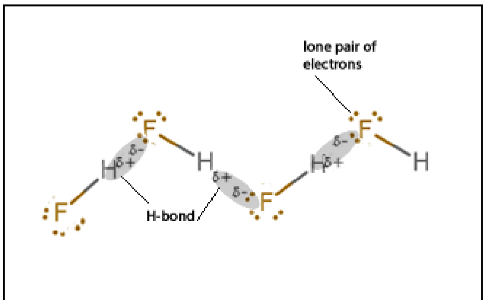
1. Consider the graph on the right.



   a. Explain why the first hydride of groups 5, 6 and 7 has a relatively higher boiling temperature than the rest of the hydrides in the group.
   The intermolecular bonds of all three, HF,NH_3 and H_2O exhibit hydrogen bonding as well as dispersion forces. Hydrogen bonding is a relatively strong form of dipole-dipole bonding and a greater amount of energy is needed to disrupt the intermolecular forces of attraction.
   b. Give an explanation of why CH_4 goes against the trend and has a lower boiling temperature than the first hydrides of every other group?
   CH_4 is symmetrical and hence non-polar substance and so the intermolecular force comprises solely of the relatively weaker dispersion forces.
   c. Explain the trend in boiling temperature from H_2S to H_2Se to H_2Te.
   As we progress down group 6 from S to Te the atoms become larger and the electronegativity of each atom significantly decreases. The difference in electronegativity between hydrogen and each atom also decreases which results in smaller dipoles and a weaker intermolecular force of attraction due to dipole-dipole bonding. One would expect that the boiling point of each hydride would be decreasing as we move down the group, but quite the opposite takes place.
   This can be explained by the increase in size of the atom as we move down a group. What happens here is the dispersion forces become larger and compensate for the decreasing forces of attraction due to dipole-dipole bonding. So as we move from H_2S to H_2Te increasing strength of dispersion forces are encountered.
   d. Consider the molecules H_2O and HF.
      i. State the intermolecular forces found in liquid H_2O and HF.
      Dispersion forces and H-bonding
      ii. HF has greater dipoles than H_2O, is a similar sized molecule to H_2O and yet it has a much lower boiling temperature, 19.7 °C, than water which boils at a staggering 100°C. Offer an explanation to justify the differences in boiling temperature between HF and H_2O.



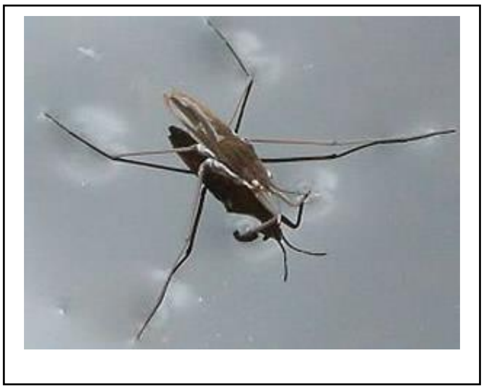
Water can form four hydrogen bonds with four other molecules



HF can form one hydrogen bond with just one other molecule

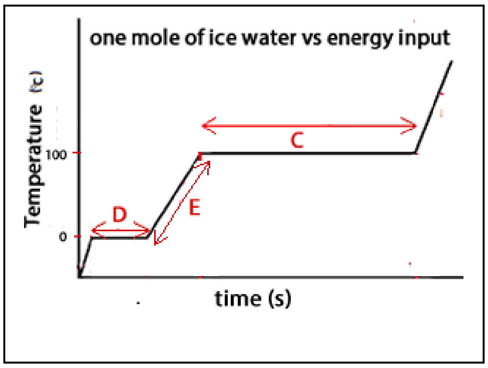
Each water molecule can form four hydrogen bonds with four other molecules while HF can only form one, as shown above. This causes a large number of water molecules to be directly linked to others around them thus increasing the force of attraction.

iii. The surface tension of water is very strong, strong enough to enable insects to land on the surface. Offer an explanation for this.

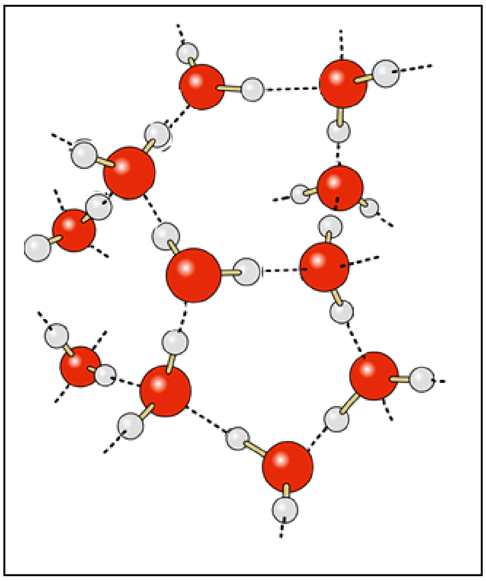


Again this can be explained by the answer given to ii. above. Each water molecule can form four hydrogen bonds with four other molecules. This causes a large number of water molecules to be directly linked to others around them thus increasing the force of attraction and forming somewhat of a network of linked molecules that provides the surface tension of water as seen in the photo on the right of an insect landing on the surface of a pool of water. These forces of attraction between water molecules are known as cohesive forces and are responsible for the phenomenon known as surface tension*.*

e. Consider the temperature vs time graph of a sample of water as it is being heated.



i. In terms of intermolecular bonds describe what is happening during section “D” and “C”.



At 0^{o}C water is changing phase from solid to liquid. Intermolecular bonds are being disrupted by the addition of energy to release molecules from their fixed positions. No temperature change occurs during this transition as the energy absorbed goes to disrupting bonds rather than contributing to the average kinetic energy of the water molecules which we see as a temperature increase.

At 100^{o}C the transition from liquid to gas takes place and here all intermolecular bonds are broken and the molecules exist in the gaseous state. Again no temperature increase is observed because energy is used in breaking bonds rather than contributing to the average kinetic energy of the water molecules.

ii. Explain why regions “D” and “C” are flat?

This is explained in i. above.

iii. Describe how the speed of the molecules differs during section “E” and “C”.

Average speed of the molecules is what we call temperature. Molecules with high average speed have a higher temperature than those that move very slowly and are therefore at a lower temperature. In section C the average speed remains constant as we can tell by the temperature remaining constant. This is because the heat energy absorbed by the liquid goes into breaking inter-molecular bonds rather than increasing the speed of the molecules and increasing he temperature. During E we see the temperature is indeed increasing. Energy is being absorbed to largely increase the speed of the molecules as opposed to break intermolecular bonds.