INTERMOLECULAR FORCES

Part 1: Van der Waals Forces

1. Draw a graph of boiling point (K) vs. M_r for the following diatomic molecules: H_2, N_2, O_2, F_2, Cl_2, Br_2, I_2.
2. Describe and explain the trend in terms of intermolecular forces.
3. On the same graph, using a different colour to mark the points, graph the boiling points of the noble gases He to Rn.
4. Describe and explain the trend in terms of intermolecular forces.
5. How does the trend for the diatomic molecules compare to that for the monatomic gases? Why do you think this happens?

* All necessary data can be found in the data booklet.

Part 2: Dipole-dipole forces

1. Go to http://phet.colorado.edu/en/simulation/molecule-polarity and run (or download and then run) the molecular polarity simulation.
2. Have a play with the 2 and 3 atoms models:
    a. Tick the 'Molecular Dipole' and 'Bond Dipole' boxes and then see what happens to these as you change the electronegativity of the atoms
    b. Take a look at the surface plots which help to visualise what is happening in terms of electrons.
    c. Switch on the magnetic field to show how the molecule aligns itself
3. For the following molecules (N_2, CO_2, HF, H_2O CH_3F, CH_2F_2, CHF_3, CF_4) you will need to:
    a. Draw (in 3-D if relevant) the molecule,
    b. Label the polarity of the individual bonds using δ^+ and δ^-
    c. Check if there is an overall dipole and if so draw an arrow pointing towards the negative end (similar to what you saw in the 2 and 3 atom models).
    d. Check the 'Real Molecules' part of the simulation to see if you were correct.

Part 3: Hydrogen Bonds

1. For each of the following pairs of molecules, research their boiling points and explain the difference in terms of intermolecular forces with a focus on hydrogen-bonding
    a. HF/HCl
    b. H_2O/H_2S
    c. NH_3/PH_3
    d. $H_2O/CH_3CH_2OH/CH_3OCH3$
    e. $CH_3CH_2CH_3/CH_3CHO/CH_3CH_2OH$