GROUP 7: THE HYDROGEN HALIDES

1. The boiling points of the rest of the hydrogen halides increase as the molecules get bigger. The extra electrons allow bigger temporary dipoles and so increase the amount of van der Waals dispersion forces between the molecules. But hydrogen fluoride also has hydrogen bonding between the HF molecules. The bond is very polar so that the hydrogen has a significant amount of positive charge and the fluorine a significant amount of negative charge. In addition, the fluorine has small intense lone pairs. Hydrogen bonds can form between the hydrogen on one molecule and a lone pair on the fluorine in its neighbour.

2. a) (i) You would see it as steamy fumes.

   (ii) $NaCl + H_2SO_4 \longrightarrow NaHSO_4 + HCl$

   (Most people would probably write this as a full equation, but if you have used an ionic version, check it against the Chemguide page.)

   b) Concentrated sulphuric acid is an oxidising agent. It is not powerful enough to oxidise chloride ions to chlorine, but is just about strong enough to oxidise bromide ions to bromine. It is easily strong enough to oxidise iodide ions to iodine.

   c) Concentrated phosphoric(V) acid isn't an oxidising agent.

3. a) A Bronsted-Lowry acid is a proton donor.

   $H_2O + HCl \longrightarrow H_3O^+ + Cl^-$

   The HCl is donating a proton (a hydrogen ion) to the water molecule.

   b) The reaction is considered as being "one-way". Virtually all the HCl reacts to give a hydroxonium ion and a chloride ion. (If you normally use one of the other names for the hydroxonium ion, that's fine.)

   c) The hydrogen fluoride reacts with water in the same way as hydrogen chloride, and the reaction is so far to the right that you can also think of it as "one-way". But this time there is such a strong attraction between the hydroxonium ion and the fluoride ion that they form a strongly bound ion pair, $H_3O^+.F^-$. To function properly as an acid, the hydroxonium ion has to be free:

   $H_3O^+.F^- \rightleftharpoons H_3O^+ + F^-$

   But this position of this equilibrium lies well to the left.