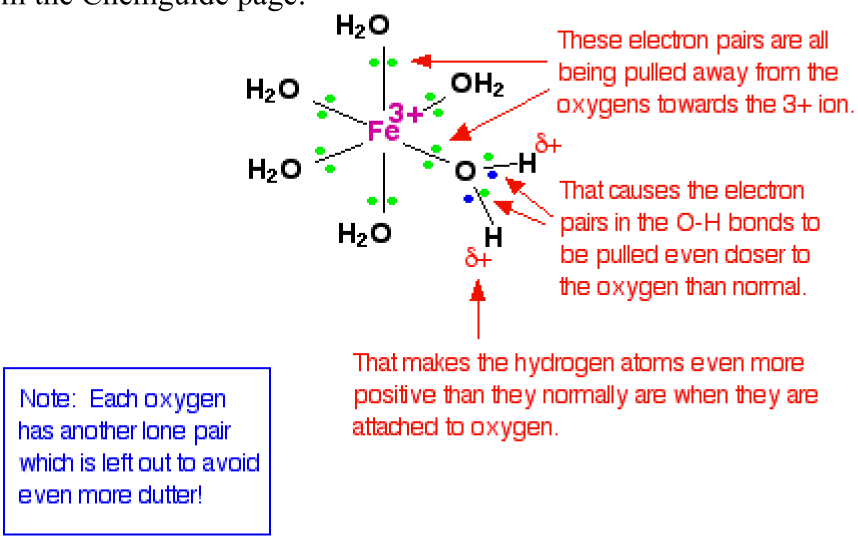
Chemguide – answers

COMPLEX IONS: ACIDITY

1. a) A lone pair on each water molecule is used to form a coordinate (dative covalent) bond using empty orbitals on the iron ion.

   b) The low pH is due to the formation of the hydroxonium ions, which are just hydrogen ions carried by water molecules. The greater the concentration of hydrogen ions, the lower the pH.

   c) It is easier (but not essential) to do this with one or more diagrams. For example, using one of the diagrams from the Chemguide page:



   (If you are just using words, you need to include at least what is shown in red on this diagram.)

   Because the hydrogens are even more positively charged than they would normally be, they are more easily attracted to, and removed by, other water molecules in the solution to form hydroxonium ions.

   d) $[Fe(H_2O)_6]^{2+} + H_2O \rightleftharpoons [Fe(H_2O)_5(OH)]^{+} + H_3O^{+}$

   The 2+ ion at the centre of the complex will have less pulling effect on the electrons in the coordinate bonds than a 3+ ion. This will mean that there will be less distortion in the O-H bonds, and so the hydrogens won't be quite so positive. That means that they won't be pulled off by other water molecules quite so easily, meaning that fewer hydroxonium ions will be formed, and so the solution is less acidic.

2. As the ion gets bigger but with the same charge, the charge is spread over a greater volume (the charge density becomes less), and so will have less effect on the electrons in the coordinate bonds. That will reduce the distortion of the O-H bonds, and weaken the positive charge on the hydrogens. That makes them less easy to remove as hydroxonium ions, and so you would expect the acidity to decrease.