Suppose we want to find the pH of 0.001 mol dm $^{-3}$ ethanoic acid. Well to start with the Ka = 1.7 x 10^{-5} mol dm^{-3}, a very small number which gives an idea as to how few molecules are actually breaking into ions.

$$CH_3COOH\ (aq) = H^+\ (aq) + CH_3COO^-\ (aq)$$

$$Ka = \frac{[H^+]\,[CH_3COO^-]}{[CH_3COOH]}$$

Rearranging the Ka expression, and remembering that the two ions must be in equal concentration:

$$[H+] = ([acid]\ Ka\ )^{0.5}$$

If the numbers get put in and crunched pH comes out to be 3.88 which is significantly higher than the 3.0 for the nitric acid earlier. If you were expecting a larger difference bear in mind that it's a *logarithmic* scale.

The one fudge I used here was to slip in the initial concentration of the acid as if it were the same thing as the equilibrium concentration, which should have been used. As long as Ka is small, say 10^{-3} or less, you can get away with this.

pKa and pKb

To satisfy my conscience I ought to mention pKa and pKb. Frankly I'm not fan of either and they seem to me a cosmetic exercise invented by those who can't do standard form. Still, this is what they are:

$$pKa = -\log [Ka] \qquad \text{and} \qquad pKb = -\log [Kb]$$

The idea is the same as pH. They give you nice numbers. The one thing you need to watch here is that acids (or bases) get stronger the pKa (or pKb) number gets *smaller* – just like pH and unlike the Ka and Kb terms which (sensibly) get larger. There you are. Yuck!

Conjugate acids and bases and salt hydrolysis

Now something a bit more interesting. Salts are made when acids and bases react with each other through neutralisation reactions. It seems reasonable to assume that they would be neutral. Sometimes yes, but sometimes no – so what's going on?

This all connects with the ideas above about why hydrogen ions break of acids in the first place. It's a question of stability (OK, entropy too but lets put that to one side) of the ions formed compared to the parent molecule. In a strong acid such as nitric acid, the nitrate ion is stabilised and shows little inclination to regain a proton and reform the molecule.

$$HNO_3\ (aq) = H^+\ (aq) + NO_3^-\ (aq)$$

Strong Conjugate Acid Insignificant Conjugate Base

Nonetheless it can happen and the nitrate ion can be thought of as a base, in fact as a conjugate base of the HNO_3 molecule. There is a sort of inverse proportionality here, in that as the acid gets stronger then the conjugate base weakens and vice versa.