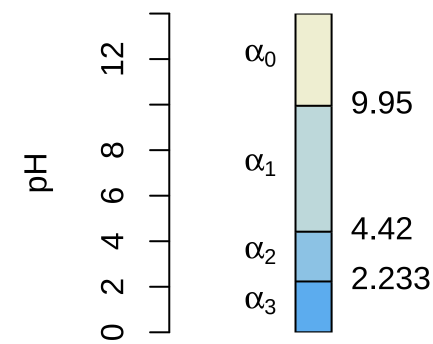
Take-Home Assignment 02

The problems here provide you with a chance to draw and to interpret ladder diagrams. For tables of equilibrium constants and standard state reduction potentials, see the appendicies to *Analytical Chemistry 2.1*. Your neatly worked solutions to these problems are due at our next class.

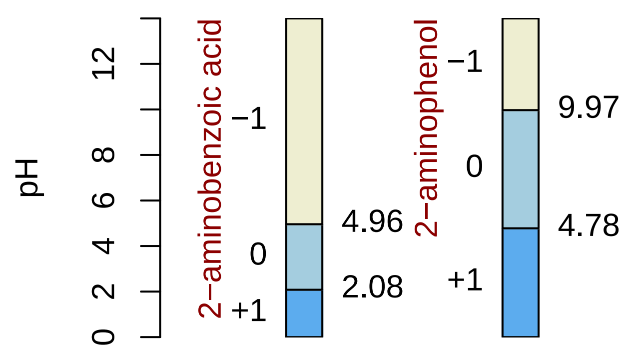
1. Draw a ladder diagram for glutamic acid. Over what range of pH values is glutamic acid predominately present in its neutral form?

   Glutamic acid is a triprotic weak acid with forms of H_3A^+, H_2A, HA^- and HA^{2-} (identified in the ladder diagram below as, respecitvely, α_3, α_2, α_1, and α_0). It is predominately in its neutral form from a pH of 2.33 to a pH of 4.42.



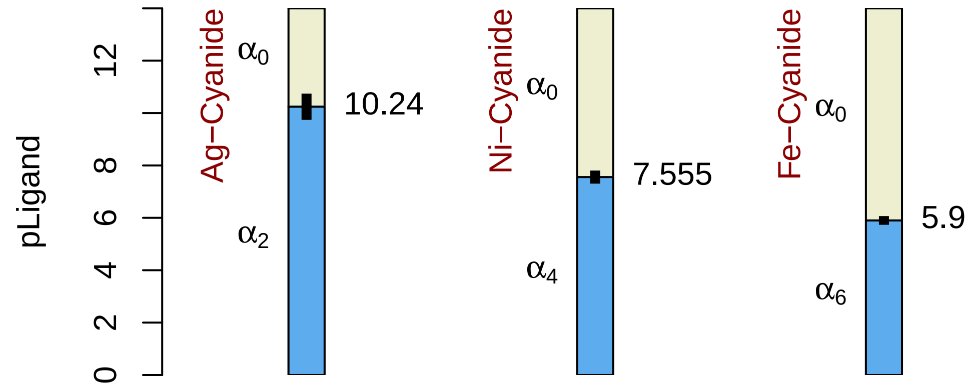
2. Draw ladder diagrams for 2-aminobenzoic acid and 2-aminophenol. Over what range, or ranges, of pH values can you separate these two compounds based on a difference in their charges?

   The ladder diagrams below show the charges for the predominate forms of 2-aminobenzoic acid and 2-aminophenol. Based on these ladder diagrams there are two possible pH ranges: 2.08–4.78 where 2-aminobenzoic acid has a charge of 0 and where 2-aminophenol has a charge of +1, and 4.97–9.97 where 2-aminobenzoic acid has a charge of -1 and where 2-aminophenol has a charge of 0.



3. Draw ladder diagrams for the metal-ligand complexes of Ag^+, Ni^{2+}, and Fe^{2+} with the cyanide ion. For Ag^+, consider just the complex $Ag(CN)_2^+$. What is the minimum concentration of CN^- needed to ensure that all three metals are fully complexed?

   The three ladder diagrams below are for the three metal-ligand complexes; for each, the symbol α_n gives the number of cyanide ligands bound to the metal ion. To ensure that all metals are fully complexed, the pL must be lower than $5.9 - \frac{1}{6} = 5.73$ (based on the Fe^{2+}–cyanide complex), or an equilibrium concentration of cyanide that is 1.85×10^{-6} M.



4. Draw ladder diagrams for the redox couples Cl_2/Cl^-, Br_2/Br^-, and I_2/I^-. Using your ladder diagram, predict whether Cl_2 can oxidize I^- and whether I_2 can oxidize Br^-.

   Using the ladder diagrams below, we see that there are no potentials where Cl_2 and I^- are their respective predominate forms; thus, we expect that they will react to form Cl^- and I_2. On the other hand, there are potentials where I_2 and Br^- are the predominate species; thus, we do not expect them to react with each other.