Chemguide – questions

COMPLEX IONS: STABILITY CONSTANTS

1. a) Iron(III) ions form a complex with cyanide ions, CN^-, with a formula $[Fe(CN)_6]^{3-}$. Write an equation for the overall formation of this ion from hexaaquairon(III) ions, $[Fe(H_2O)_6]^{3+}$.

   b) Use this equation to write an expression for the overall stability constant, K_{stab}, for the hexacyanoferrate(III) ion.

   c) A data book quotes a value for log K_{stab} as "about 31". Convert this into a value for K_{stab}. What does this tell you about this complex ion?

2. The table below shows the stability constants for each of the stages in the replacement of four of the water molecules in $[Cu(H_2O)_6]^{2+}$.

ion	K_n	Value (mol^{-1} dm^3)
$[Cu(NH_3)(H_2O)_5]^{2+}$	K_1	1.78×10^4
$[Cu(NH_3)_2(H_2O)_4]^{2+}$	K_2	4.07×10^3
$[Cu(NH_3)_3(H_2O)_3]^{2+}$	K_3	9.55×10^2
$[Cu(NH_3)_4(H_2O)_2]^{2+}$	K_4	1.74×10^2

   a) Write the equation for the formation of each ion from the previous one with one ammonia less, and use this to write an expression for each stability constant.

   b) Write an expression for the overall stability constant, K_{stab}, for the formation of the complex ion $[Cu(NH_3)_4(H_2O)_2]^{2+}$.

   c) Use the values in the table for K_1, K_2, K_3 and K_4 to calculate the overall stability constant, K_{stab}. Explain why your method works.

3. Only do this question if your syllabus expects you to know about the chelate effect.

   The log K_{stab} values for two nickel complexes are: $[Ni(NH_3)_6]^{2+}$ 8.74
   $[Ni(EDTA)]^{2-}$ 18.6

   Both of these are octahedral complexes.

   a) Write the equations for the formation of both of these complexes from hexaaquanickel(II) ions.

   b) Explain why the stability constant of the complex with EDTA is much greater than that of the complex with ammonia.