Marks 5

- Cisplatin, $[Pt(NH_3)_2Cl_2]$, is a particularly effective chemotherapy agent against certain types of cancer. Calculate the concentration of Pt^{2+}(aq) ions in solution when 0.075 mol of cisplatin is dissolved in 1.00 L of a 1.00 M solution of NH_3. K_{stab} of $[Pt(NH_3)_2Cl_2] = 3.4 \times 10^{12}$.

The initial concentration of cisplatin when 0.075 mol is dissolved in 1.00 L is 0.075 M.

As K_{stab} refers to the formation of the complex, the reaction table is:

	Pt^{2+}(aq)	$2Cl^-$(aq)	$2NH_3$(aq)	$\rightleftharpoons$	$[Pt(NH_3)_2Cl_2]$
Initial	**0**	**0**	**1.00**		**0.075**
Change	$+x$	$+2x$	$+2x$		$-x$
Equilibrium	x	$2x$	$1.00 + 2x$		$0.075 - x$

Hence:

$$K_{stab} = \frac{[Pt(NH_3)_2Cl_2]}{[Pt^{2+}][Cl^-]^2[NH_3]^2} = \frac{(0.075-x)}{(x)(2x)^2(1.00+2x)^2} = 3.4 \times 10^{12}$$

As K_{stab} is so large, x will be very, very small and so $(1.00 + 2x) \sim 1.00$ and $(0.075 - x) \sim 0.075$. With this:

$$K_{stab} \sim \frac{(0.075)}{(x)(2x)^2(1.00)^2} = \frac{(0.075)}{(4x)^3} = 3.4 \times 10^{12}$$

$x = [Pt^{2+}(aq)] = 1.8 \times 10^{-5}$ **M**

Answer: $\mathbf{1.8 \times 10^{-5}}$ **M**

What changes would occur to the values of K_{stab} for cisplatin and the concentration of Pt^{2+}(aq) ions if solid KCl were dissolved in the above solution?

K_{stab}	increase	**no change**	decrease
$[Pt^{2+}(aq)]$	increase	no change	**decrease**

(i) K_{stab} is the stability constant – it is a constant at any given temperature.

(ii) From Le Chatelier's principle, if $[Cl^-(aq)]$ is increased then the equilibrium will shift to the right and so $[Pt^{2+}(aq)]$ will decrease.