**Marks
4**

- The general formula for a nickel(II) chloride compound complexed with ammonia is $[Ni(NH_3)_x]Cl_2$. A 0.59 g sample of the salt was dissolved in water and the ammonia from it was titrated with 153 mL of 0.100 M HCl. What is the value of the coefficient x?

The molar mass of $[Ni(NH_3)_x]Cl_2$ is:

$(58.69 \text{ (Ni)} + x (14.01 \text{ (N)} + 3 \times 1.008 \text{ (H)}) + 2 \times 35.45 \text{ (Cl)}) \text{ g mol}^{-1}$

$= (129.59 + 17.034x) \text{ g mol}^{-1}$

A 0.59 g sample therefore corresponds to:

$$\text{number of moles} = \frac{\text{mass}}{\text{molar mass}} = \frac{0.59}{(129.59 + 17.034x)} \text{ mol} \qquad (1)$$

The number of moles in 153 mL of 0.100 M HCl is:

number of moles = concentration × volume

$= 0.100 \text{ mol L}^{-1} \times 0.153 \text{ L} = 0.0153 \text{ mol}$

Ammonia reacts with HCl according to the reaction $NH_3 + HCl \rightleftharpoons NH_4Cl$ and so this is equal to the number of moles of NH_3 present. Each mol of $[Ni(NH_3)_x]Cl_2$ contains x mol of NH_3 so the number of moles of $[Ni(NH_3)_x]Cl_2$ is:

number of moles = 0.0153 / x mol   (2)

The value of x is calculated by equating (1) and (2). This is easiest to achieve by trial and error.

x	(1) / mol	(2) / mol
1	0.0040	0.015
2	0.0036	0.0077
3	0.0033	0.0051
4	0.0030	0.0038
5	0.0027	0.0031
6	0.0026	0.0026
7	0.0024	0.0022

The best agreement is for $x = 6$ - a common coordination number for Ni(II).

Answer: **6**