

Acids and Bases



#6

Calculate the pH of a solution of 5.258 g NH_4Cl in 750 mL of solution.

Solution

NH_4Cl :

$$5.258 \text{ g} = \frac{5.258 \text{ g}}{53.5 \frac{\text{g}}{\text{mol}}} = 0.0983 \text{ mol}$$

$$\frac{0.0983 \text{ mol}}{0.750 \text{ L}} = 0.131 \frac{\text{mol}}{\text{L}}$$

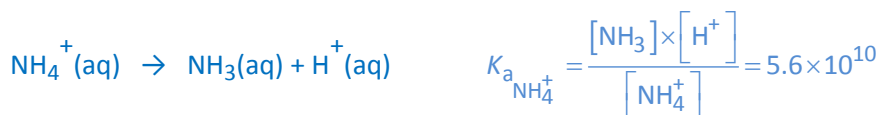
NH_4Cl :

= salt, completely dissociated



NH_4^+ = weak acid (stronger than water)

Cl^- = weak base, weaker than water



$\frac{\text{mol}}{\text{L}}$	NH_4^+	NH_3	H^+
Start	0.131	0	0*
Δ	-x	+x	+x
Equilibrium	$0.131 - x$	x	x

(*) The hydrogen ions delivered by the ionization of water are neglected. The weak acid NH_4^+ ($K_a = 5.6 \times 10^{-10}$) is much stronger than the weak acid H_2O ($K_a = 1.0 \times 10^{-14}$).

$$\begin{aligned} K_{a_{\text{NH}_4^+}} &= \frac{x^2}{0.131 - x} = 5.6 \times 10^{-10} \\ \Rightarrow x^2 + 5.6 \times 10^{-10}x - 7.3 \times 10^{-11} &= 0 \\ \Rightarrow x &= 8.5 \times 10^{-6} \end{aligned}$$

$\frac{\text{mol}}{\text{L}}$	NH_4^+	NH_3	H^+
Equilibrium	0.131	8.5×10^{-6}	8.5×10^{-6}

$\Rightarrow \text{pH} = 5.07$