

Acid-base worked example

2 When ammonium salts are dissolved in water the following equilibrium is set up:



a Write the full expression for the dissociation constant, K_a , for this equilibrium.

$$K_a = \frac{[\text{NH}_3][\text{H}^+]}{[\text{NH}_4^+]}$$

b The pH of a solution of ammonium chloride is 5.6.

i Calculate the hydrogen ion concentration in this solution, showing the mathematical relationship you use.

pH(NH₄Cl) is 5.6

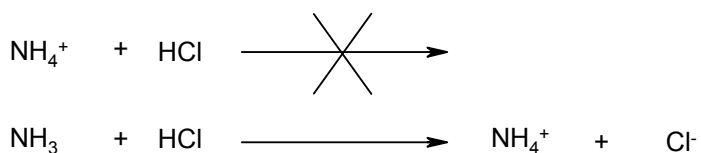
$$\text{pH} = -\log_{10}[\text{H}^+]$$

$$[\text{H}^+] = 10^{-\text{pH}}$$

$$= 10^{-5.6}$$

$$= \underline{2.5 \times 10^{-6} \text{ mol dm}^{-3}}$$

ii What will happen to the concentration of ammonium ions in solution when hydrochloric acid is added to the ammonium chloride? Explain your answer.



Therefore $[\text{NH}_4^+]$ will increase when HCl is added, due to the NH_3 reacting with HCl to form NH_4^+ .

PTO

c A mixture of ammonium chloride and ammonia solution acts as a buffer.

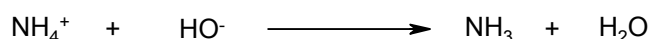
i What is meant by a buffer solution?

Buffer solutions resist change in pH on addition of small amounts of acid or base.

ii Explain the changes which occur when a solution containing hydroxide ions, HO⁻, is added to this buffer.

This buffer contains NH₄⁺ and NH₃.

On addition of HO⁻, the following occurs:



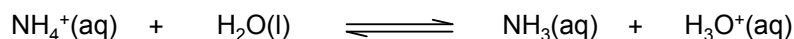
i.e. the NH₄⁺ absorbs the HO⁻.

In terms of the original equilibrium:



The concentration of NH₃ has increased and the concentration of NH₄⁺ has decreased. Therefore the equilibrium moves to the left hand side, so as to minimize the effect of these changes in concentration.

d The equilibrium involving ammonium ions and ammonia can be written showing the water molecules:



Use the Bronsted-Lowry theory to explain whether water is acting as an acid or a base in this equilibrium.



Water is behaving as a base because it is accepting H⁺.