SL & HL Answers to pH scale questions

1. i. The solution has been diluted 10 times so the new pH is 2 (an increase in one pH unit).

ii. The solution has now been diluted 100 times so the new pH is 3 (an increase in two pH units).

iii. The solution is now neutral so the pH will be 7.

2. 10.0 cm^3 of a solution of 0.100 mol dm^{-3} sodium hydroxide, NaOH(aq) has a pH of 13.

i. The solution has been diluted 100 times so the new pH is 11 (a decrease in two pH units).

ii. The solution has been diluted 1000 times so the new pH is 10 (a decrease in three pH units).

iii. The excess amount of NaOH is equivalent to 10 cm^3 of 0.100 mol dm^{-3} sodium hydroxide solution, NaOH(aq) and as the total volume has been made up to 100 cm^3 this has been diluted ten times so the new pH will be 12.

3. i. $pH = -\log_{10}[H^+] = -\log_{10} 0.200 = 0.70$. **ii.** $pH = -\log_{10}[H^+] = -\log_{10} 0.400 = 0.40$

4. $[H^+] \times [OH^-] = 1.00 \times 10^{-14}$; $[H^+] = 1.00 \times 10^{-14} \div 3.00 \times 10^{-3} = 3.33 \times 10^{-12}$ mol dm^{-3}

$pH = -\log_{10}[H^+] = -\log_{10} 3.33 \times 10^{-12} = 11.5$

5. i. Ethanoic acid is a weak acid so is only slightly dissociated into its ions so the concentration of hydrogen ions will be lower than for nitric acid which being a strong acid is fully dissociated.

ii. As the difference in pH is two units, nitric acid is approximately one hundred times stronger.

iii. It needs to be diluted 100 times so 2475 cm^3 of distilled water needs to be added to bring the total volume to 2500 cm^3.

6. Potassium hydroxide is a strong alkali so is completely dissociated into potassium ions and hydroxide ions in aqueous solution. Ammonia is a weak base and only slightly reacts with water to form ammonium ions and hydroxide ions.

$$NH_3(aq) + H_2O(l) \rightleftarrows NH_4^+(aq) + OH^-(aq)$$

As the concentration of hydroxide ions in ammonia solution is lower than the concentration of hydroxide ions in potassium hydroxide solution the concentration of hydrogen ions will be higher so the pH will be lower.