SL & HL Questions on the pH scale

1. 10.0 cm^3 of a solution of 0.100 mol dm^{-3} hydrochloric acid, HCl(aq), has a pH of 1.

i. Deduce the pH of the resulting solution if 90.0 cm^3 of distilled are mixed with the above solution.

ii. Deduce the pH of the mixture if a further 900 cm^3 of distilled water are added to the solution.

iii. Deduce the pH of the resulting solution if 10.0 cm^3 of 0.100 mol dm^{-3} sodium hydroxide solution, NaOH(aq), are added to 10.0 cm^3 of 0.100 mol dm^{-3} hydrochloric acid solution.

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

i. Deduce the pH of the resulting mixture if the total volume is made up to 1.00 dm^3 with distilled water.

ii. Deduce the pH if 9.990 dm^3 of water is added to 10.0 cm^3 of a solution of 0.100 mol dm^{-3} sodium hydroxide, NaOH(aq).

iii. Deduce the pH of the resulting solution if 20.0 cm^3 of 0.100 mol dm^{-3} sodium hydroxide solution, NaOH(aq), is added to 10.0 cm^3 of a solution of 0.100 mol dm^{-3} hydrochloric acid, HCl(aq), followed by the addition of 70.0 cm^3 of distilled water.

3. Calculate the pH of **i.** 0.200 mol dm^{-3} hydrochloric acid solution, HCl(aq) and **ii.** 0.200 mol dm^{-3} sulfuric acid solution, H_2SO_4(aq), (assume sulfuric acid is a strong diprotic acid which is not strictly true).

4. Determine the pH of an alkaline solution with a hydroxide concentration of 3.00 x 10^{-3} mol dm^{-3}.

5. The pH of a solution of 0.100 mol dm^{-3} ethanoic acid, CH_3COOH(aq), is about 3 and the pH of a solution of 0.100 mol dm^{-3} nitric acid, HNO_3(aq), is 1.

(a) Explain why the solution of ethanoic acid has a higher pH value even though both acids have the same concentration.

(b) Approximately how many times stronger is the nitric acid solution compared to the ethanoic acid solution?

(c) Approximately how much distilled water would need to be added to 25 cm^3 of the nitric acid solution so that the resulting mixture has the same pH as the ethanoic acid solution?

6. The pH of 0.100 mol dm^{-3} potassium hydroxide solution, KOH(aq), is 13 and the pH of 0.100 mol dm^{-3} ammonia solution, NH_3(aq), is about 11. Explain why the pH values of the two solutions are different even though their concentrations