ACID BASE PRACTICE QUESTIONS 1

9. In an acid-base titration, 1.0 mol L^{-1} HCl(aq) (from a burette) is added slowly to 20.0 mL of 1.0 mol L^{-1} NaOH(aq) in a conical flask.

(a) Calculate the pH of the solution in the conical flask after 19.90 mL of the HCl(aq) has been added. Assume the total volume of solution is now 39.90 mL.

(b) Calculate the pH of the solution in the flask after 20.10 mL of the HCl(aq) has been added. Assume the total volume of solution is now 40.10 mL.

(c) On the basis of the above pH changes, explain why both methyl orange and phenolphthalein are suitable indicators for this titration.

9(a) $n(OH^-)$ = c.V = (1.00 mol L^{-1})(0.020 L) = 0.020 mol.
$n(H^+)$ = c.V = (1.00 mol L^{-1})(0.0199 L) = 0.0199 mol.
Excess $n(OH^-)$ = 0.0001 mol
$c(OH^-)$ = n / V_T = (0.0001 mol) / (0.0399 L) = 0.00251 mol L^{-1}
$c(H^+)$ = (10^{-14}) / (0.00251) = 3.98 x 10^{-12}
Hence, pH = 11.4 (2)

9(b) $n(OH^-)$ = 0.020 mol
$n(H^+)$ =).0201 mol
excess $n(H^+)$ = 0.0001 mol.
$c(H^+)$ = (0.0001 mol) / (0.0401 L) = 0.00249 mol L^{-1}
Hence, pH = 2.6 (2)

9(c) In the last 0.2 mL, the pH has dropped from 11.4 to 2.6 ie by 8.8 points. Methyl Orange and Phenolphthalein are suitable indicators for this titration because they both undergo colour changes (pink to clear and yellow to orange-red) in this range

(2)

4. A solution was prepared by mixing dilute sulfuric acid and dilute tartaric acid. Tartaric acid has the formula HOOCCHOHCHOHCOOH and in acid-base reactions, releases two protons and forms the tartrate ion: $OOCCHOHCHOHCOO^{2-}(aq)$
The mixture of the two acids was analysed as follows:

(i) 25·00 mL of the mixture was taken, and it required 29·8 mL of 0·504 mol L^{-1} NaOH to neutralize both acids.

(ii) A second 25·00 mL of the mixture was treated with excess barium nitrate solution, and resulted in the precipitation of 0.712 g of barium sulfate.

Calculate the concentration of sulfuric acid and tartaric acid in moles per litre in the mixture .

[10 marks]

4. The first reaction is : $H^+_{total} + OH^- \rightarrow H_2O(l)$

$n(H^+)_{total} = n(OH^-) = n(NaOH) = c.V = (0.504 \text{ mol } L^{-1})(0.0298 \text{ L}) = 0.01502$ mol.

The second reaction produces barium sulfate solid:

$m(BaSO_4) = 0.712$ g

$n(BaSO_4) = m/M = (0.712 \text{ g}) / (233.36 \text{ g mol}^{-1}) = 3.051 \times 10^{-3}$ mol.

$n(H_2SO_4) = n(BaSO4) = 0.003051$ mol.

$c(H_2SO_4) = n/V = (0.003051 \text{ mol}) / (0.025 \text{ L}) = 0.122 \text{ mol } L^{-1}$

$n(H^+)sulfuric = 2n(H_2SO_4) = 0.006102$ mol.

Hence, $n(H^+)_{tartaric} = n(H^+)_{total} - n(H^+)_{sulfuric}$

$= 0.01502 \text{ mol} - 0.006102 \text{ mol} = 0.008918$ mol.

$n(\text{tartaric acid}) = ½\, n(H^+)_{tartaric} = 4.459 \times 10^{-3}$ mol

Hence, $c(\text{tartaric acid}) = n / V = (4.459 \times 10^{-3} \text{ mol}) / (0.\ 25 \text{ L}) = 0.178 \text{ mol } L^{-1}$

Answer: The concentration of sulfuric acid is 0.122 mol L^{-1} (5)

and The concentration of tartaric acid is 0.178 mol L^{-1} (5)