27.5/30

Chemistry 205 Report
Acid-Base Titration

Name:

Date: 15 - 02 - 2013

Purpose: - To learn the concept and technique of titration
- to standardize a sodium hydroxide (NaOH) solution against a primar standard acid
- To determine the concentration of an unknown acid solution by titration with the standardized base solution.

Table 1: Preparation of Standard KHP Solution

Mass of bottle + KHP	18.5132 g
Mass of empty bottle	15,3566 g
Mass of KHP	3,1566 g
Volume of solution	250,0 ml

± 0,0001 g

± 0,1 ml

$n_{KHP} = \frac{m}{M} = \frac{3,1566}{204,23} = 0,0157$ mol

$M_{KHP} = \frac{n}{V} = \frac{0,015456}{250,0 \times 10^{-3}} = 0,061824$

only 4 sig f

-1/2 -1/2

Table 2: Standardization of NaOH Against Standard KHP

Trial	Upper buret reading	Lower buret reading	Volume of NaOH ± 0,02 ml (ml)
1	0.00	15,00	15,00
2	15,00	29,50	14,50
3	29,50	43,30	13.8
blank	0,00	0,20	0,20

$\bar{V}_{NaOH} = 14,43$ ml.

$V_{NaOH} = \bar{V}_{NaOH} - V_{blank}$
$= 14,43 - 0,20$
$= 14,23$

Volume of KHP aliquot = 25,00 ml ± 0,02 ml

M of NaOH = $(M \times V)_{NaOH} = (M \times V)_{KHP}$ | $M_{NaOH} = \frac{(M \times V)_{KHP}}{V_{NaOH}} = \frac{0,061824 \times 25,00 \times 10^{-3}}{14,23 \times 10^{-3}}$

$= 0,1086$ M.

Table 3: Analysis of Acid Unknown # 2.

Trial	Upper buret reading	Lower buret reading	Volume of NaOH
1	8,00	23,80	15,80
2	23,80	39,80	16,00
3	0,30	16,00	15,7

$\bar{V}_{NaOH} = 15,80$ ml

$V_{NaOH} = \bar{V}_{NaOH} - V_{blank}$

Volume of **acid** unknown (aliquot) = 25,00 ml. ± 0,02 ml

M of unknown = $M_a \times V_a = M_b \times V_b$ | $M_a = \frac{M_b \times V_b}{V_a} = \frac{0,1086 \times 15,80 \times 10^{-3}}{25,00 \times 10^{-3}} = 0,0686$ M.

% error = 0,34%.

Questions

1. In the part of acid unknown analysis, if an air bubble is originally trapped in the buret tip, but disappears during the titration; will the reported molar concentration of the unknown be smaller or larger than the true value? Explain briefly.

(1.5) $M = \frac{m}{V}$ if an air bubble is origanally troped in the buret tip, but disappears during the titration, the volume will decrease then, the mol or concentration will increase. because the volume and the molar contentration are inversly proportional

2. A volume of 17.83 mL $Ca(OH)_2$ solution is needed to completely neutralize 50.00 mL of 0.2464 M HNO_3 solution.

a) Calculate the molarity of the $Ca(OH)_2$ solution? $Ca(OH)_2 + 2HNO_3 \rightarrow Ca(NO_3) + 2H_2O$

$n_{Ca(OH)_2} = \frac{n_{HNO_3}}{2}$

$2(M \times V)_{Ca(OH)_2} = (M \times V)_{HNO_3}$

$2(M \times 17,83)\,mL = (0,2464\,M \times 50,00\,mL)$

$2(M \times 17,83) = 12,32 \Rightarrow 2M = \frac{12,32}{17,83} = 0,6910 \Rightarrow M = \frac{0,6910}{2} = \boxed{0,3455\,M}$

b) Calculate the mass of $Ca(OH)_2$ in the above used volume of $Ca(OH)_2$ solution.

$M = \frac{n}{V} \Rightarrow 0,3455 = \frac{n}{17,83} \Rightarrow n = 6.160\,mmol = 0,006160\,mol$

$n = \frac{m}{M} \Rightarrow m = n \times M = 0,006160 \times 74,0918 = \boxed{0,4564\,g}$

$M_{Ca(OH)_2} = 40,078 + 2(15,999 + 1,0079) = 74,0918\,g/mol$

3. Calculate the pH of:

a) 1.0×10^{-3} M HCl solution. Since HCl is a strong acid. $HCl \rightarrow H^+_{(aq)} + Cl^-_{(aq)}$

$pHCl = -\log[H^+] = -\log(1,0 \times 10^{-3}) = \boxed{3,00}$

b) 0.020 M $Ba(OH)_2$ solution

Since $Ba(OH)_2$ is a strong base it is 100% ionized $Ba(OH)_2 \rightarrow Ba^{2+}_{(aq)} + 2OH^-_{(aq)}$
As each $Ba(OH)_2$ dissociates to makes $2OH^-$ a 0,020 M solution has $[OH^-] = 2 \times 0,020 = 0,040\,M$. As definition $pOH = -\log[OH^-]$ so $pOH = -\log(0,040) = 1,40$. As $pH + pOH = 14,00 \Rightarrow pH = 14,00 - 1,40 = \boxed{12,60}$

4. The equivalence point of the titration of a weak base with a strong acid occurs at pH 4.67. Which of the following indicators is the best to detect the end-point of the titration?

Indicator	Color change	pH range
Methyl orange	Red – yellow	3.3 – 4.5
Bromocresol green	Yellow – blue	3.8 – 5.4
Bromothymol blue	Yellow - blue	6.0 – 7.6
Phenolphthalein	Colorless - pink	8.3 – 10.0

The best indicator to detect the end point of the titration is the indicator whose color range includes the equivalence pH here the best indicator is Bromocresol green.

$3,8 < 4,67 < 5,4$