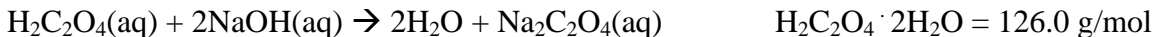


Volumetric Analysis I: NaOH Standardization I



Suppose that you weight out a 1.218 g sample of $\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$

$$[1.218 \text{ g}] / [126.0 \text{ g/mol}] = 9.667 \times 10^{-3} \text{ mol of } \text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$$

Oxalic acid dehydrate ionizes to yield 2 protons, the two waters just go into the solution



what yields $2 \times [9.667 \times 10^{-3} \text{ mol of } \text{H}^+]$. Notice the Acid:Base mole ratio is 1:2

If the NaOH solution was 0.0995 mol/L in concentration, then the volume of this solution required to neutralize the acid would be

$$[1.933 \times 10^{-2} \text{ mol of } \text{H}^+] / [0.0995 \text{ mol/L}] = 194.3 \times 10^{-3} \text{ L of NaOH}$$

which equals 194.3 mL, a volume much larger than our buret's capacity.

The best way to do this is to place the 1.218 g of $\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$ in a 100.0 mL volumetric flask and take aliquots. For a 17.01 mL aliquot, the amount of $\text{H}_2\text{C}_2\text{O}_4$ being withdrawn is 17.01 % of the total...

$$9.667 \times 10^{-3} \text{ mol of } \text{H}_2\text{C}_2\text{O}_4 \times [17.01 \text{ mL}/100.0 \text{ mL}] = 1.643 \times 10^{-3} \text{ mol of } \text{H}_2\text{C}_2\text{O}_4$$

Suppose the volume of NaOH solution required to neutralize the acid is $34.41 \times 10^{-3} \text{ L}$, then the molarity of the NaOH solution is

$$[2 \times 1.643 \times 10^{-3} \text{ mol of } \text{H}_2\text{C}_2\text{O}_4] / 34.41 \times 10^{-3} \text{ L} = 0.0995 \text{ mol/L}$$

Trial	Example	I	II	III	IV
Acid Vol [L X 10 ⁻³]	17.01	_____	_____	_____	_____
Mol of Acid X 10 ⁻³	1.643	_____	_____	_____	_____
Mol eq of Base X 10 ⁻³	3.286	_____	_____	_____	_____
Buret Read ₁ [L X 10 ⁻³]	10.97	_____	_____	_____	_____
Buret Read ₂ [L X 10 ⁻³]	45.38	_____	_____	_____	_____
Read ₂ - Read ₁ [L X 10 ⁻³]	34.41	_____	_____	_____	_____
M of NaOH [mol/L]	0.0995	_____	_____	_____	_____

Average Molarity of NaOH: _____ [mol / L]

Volumetric Analysis II: NaOH Standardization II



Again we use the same solution as last time. Suppose you weight out a 0.456 g sample of $\text{KHC}_8\text{H}_4\text{O}_4$.

$$[0.456 \text{ g}] / [204.0 \text{ g/mol}] = 2.235 \times 10^{-3} \text{ mol of KHC}_8\text{H}_4\text{O}_4$$

Potassium hydrogen phthalate ionizes to yield 1 proton



what yields 2.235×10^{-3} mol of H^+ .

If the sample requires 22.47 mL of NaOH to reach the equivalence point, then the molarity of the NaOH solution is

$$[2.235 \times 10^{-3} \text{ mol of H}^+] / [22.47 \times 10^{-3} \text{ L}] = 0.0995 \text{ mol/L}$$

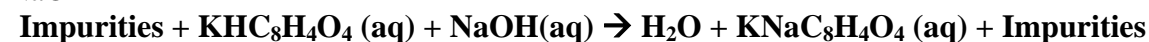
Trial	Example	I	II	III	IV
Acid Mass [grams]	0.456	_____	_____	_____	_____
Mol of Acid $\times 10^{-3}$	2.235	_____	_____	_____	_____
Mol eq of Base $\times 10^{-3}$	2.235	_____	_____	_____	_____
Buret Read ₁ [L $\times 10^{-3}$]	10.02	_____	_____	_____	_____
Buret Read ₂ [L $\times 10^{-3}$]	32.49	_____	_____	_____	_____
Read ₂ - Read ₁ [L $\times 10^{-3}$]	22.47	_____	_____	_____	_____
M of NaOH [mol / L]	0.0995	_____	_____	_____	_____

Average Molarity of NaOH:_____ [mol / L]

Volumetric Analysis III: Percent purity of a $\text{KHC}_8\text{H}_4\text{O}_4$ sample



Now we make use of the standardized NaOH solution to determine the percent purity of a Potassium hydrogen phthalate sample. We use our standard solution, (say 0.0995 M)
This time you weight out a 0.8420 g sample of impure $\text{KHC}_8\text{H}_4\text{O}_4$. Again, the potassium hydrogen phthalate ionizes to yield **1** proton, but the impurities do not react with the NaOH



Suppose that $25.44 \times 10^{-3} \text{ L}$ of the standard NaOH solution were required to neutralize the acid. From stoichiometry we get that the number of moles of acid in the sample is

$$[25.44 \times 10^{-3} \text{ L}] \times [0.0995 \text{ mol/L}] = 2.531 \times 10^{-3} \text{ mol of KHC}_8\text{H}_4\text{O}_4$$

Using the molar mass of $\text{KHC}_8\text{H}_4\text{O}_4$ we get the number of grams

$$[2.531 \times 10^{-3} \text{ mol of KHC}_8\text{H}_4\text{O}_4] \times [204.0 \text{ g/mol}] = 0.5164 \text{ g of KHC}_8\text{H}_4\text{O}_4$$

Then we determine the percent purity of the sample

$$[0.5164 \text{ g of KHC}_8\text{H}_4\text{O}_4 / 0.8420 \text{ g of sample}] \times [100] = 61.33 \% \text{ KHC}_8\text{H}_4\text{O}_4 \text{ by mass}$$

Trial	Example	I	II	III	IV
Sample Mass [grams]	0.842	_____	_____	_____	_____
Buret Read ₁ [L X 10 ⁻³]	12.35	_____	_____	_____	_____
Buret Read ₂ [L X 10 ⁻³]	37.79	_____	_____	_____	_____
Read ₂ - Read ₁ [L X 10 ⁻³]	25.44	_____	_____	_____	_____
Mol of Base X 10 ⁻³	2.531	_____	_____	_____	_____
Mol eq of Acid X 10 ⁻³	2.531	_____	_____	_____	_____
Mass of Acid [g]	0.5164	_____	_____	_____	_____
% $\text{KHC}_8\text{H}_4\text{O}_4$	61.33	_____	_____	_____	_____

Average % $\text{KHC}_8\text{H}_4\text{O}_4$ by mass:_____