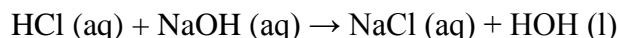


Acid- Base Titrations

An acid-base titration is a quantitative reaction (complete - not equilibrium) between an acid and a base. Either the acid is strong, or base is strong, and often both are.

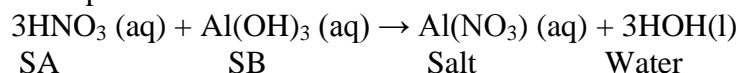
A titration is performed to determine an unknown variable with respect to the acid or the base, usually concentration. All other variables will be known.

A titration is a special double replacement reaction where **the acid and base neutralize** each other. A classic example would be:

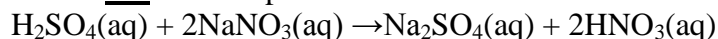


All strong acid - strong base neutralization reactions produce H₂O and a “salt”

Example:



This is **not** an example of an acid-base neutralization:



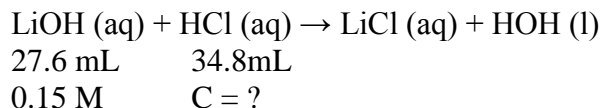
WHY? There is no water produced!

Stoichiometric calculations can be performed to determine one of :

- 1) molarity of the acid or base
- 2) volume of the acid or base
- 3) extensions to include pH or pOH

A typical question could be:

27.6 mL of 0.15 M of LiOH completely neutralized 34.8 mL of HCl. Calculate the concentration of HCl used.



$$\begin{aligned} n &= Cv \\ &= (0.15\text{M}) (0.0276\text{L}) \\ &= 0.00414 \end{aligned}$$

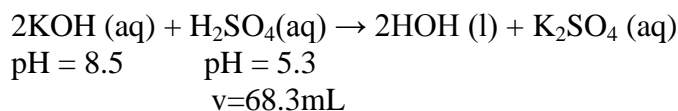
$$\begin{aligned} n \text{ (wanted)} &= n \text{ (given)} \times \text{wanted/given} \\ &= 0.00414 \text{ mol} \times 1/1 \\ &= 0.00414 \text{ mol} \end{aligned}$$

$$\begin{aligned} C &= n/v \\ &= \frac{0.00414 \text{ mol}}{0.0348 \text{ L}} \end{aligned}$$

$$= 1.2 \times 10^{-1} \text{ M}$$

(For a quickie multiple choice answer in a 1:1 mol ratio, use $C_a v_a = C_b v_b$)

Example #2 A solution of KOH has a pH of 8.5. It is neutralized when 68.3 mL of sulfuric acid is mixed with it. If the pH of the acid was 5.3, calculate the volume of the base.



We need concentrations to find moles to find mole ratio to find volume.

$$\begin{aligned} \text{pH} &= -\log [\text{H}_2\text{SO}_4] \text{ (x 2)} \\ [\text{H}_2\text{SO}_4] &= 10^{-\text{pH}} \times \frac{1}{2} \text{ (mole ratio because there are 2 H)} \\ [\text{H}_2\text{SO}_4] &= 10^{-5.3} \times \frac{1}{2} \\ &= 5.01 \times 10^{-6} \times \frac{1}{2} \\ &= 2.51 \times 10^{-6} \text{ mol/L} \end{aligned}$$

$$\begin{aligned} \text{pOH} &= -\log [\text{KOH}] \\ [\text{KOH}] &= 10^{-\text{pOH}} \\ &= 10^{-5.5} \\ &= 3.16 \times 10^{-6} \text{ M} \end{aligned}$$

Next we need to find the number of moles of H_2SO_4 for the mole ratio equation:

$$\begin{aligned} n &= Cv \\ &= (2.51 \times 10^{-6} \text{ mol/L}) (0.0683\text{L}) \\ &= 1.71 \times 10^{-7} \text{ mol} \end{aligned}$$

Now our mole ratio equation

$$\begin{aligned} n \text{ of KOH (wanted)} &= n \text{ of H}_2\text{SO}_4 \text{ (given)} \times \frac{2}{1} \\ &= 1.71 \times 10^{-7} \times \frac{2}{1} \\ &= 3.42 \times 10^{-7} \text{ mol} \end{aligned}$$

Now we can find the volume

$$\begin{aligned} v &= n/C \\ &= \frac{3.42 \times 10^{-7} \text{ mol}}{3.16 \times 10^{-6} \text{ mol/L}} \\ &= 0.108 \text{ L} \\ &= 0.1 \text{ L} \end{aligned}$$

(Whew! That one was wicked, they're not all that bad!)