Acid-Base Titration Problems

There are many equally correct ways to do titration problems. This way is easiest for me. You don't have to do them this way. Feel free to do them whatever way is easiest for you.

Any time you're doing acid-base chemistry and you see the words *titrate*, *titration*, *neutralize*, *neutralization*, *end point*, or *equivalence point*, you know that when the reaction is complete,

$$\textbf{moles } H^+ = \textbf{moles } OH^-$$

But we're never actually given the moles of H^+ and OH^-. Instead we know the moles of the acid or base those ions came from. We can calculate moles of H^+ and OH^- from the moles of acid and base by using this equation:

$$\textbf{Moles of Acid} \times {}^{\#} \textbf{ of } H^+ \textbf{ in the acid} = \textbf{Moles of Base} \times {}^{\#} \textbf{ of } OH^- \textbf{ in the base}$$

If your acid or base is a solution, you calculate moles using M × V.

If your acid or base is a solid, then you calculate moles using $\frac{\text{g}}{\text{MW}}$.

You can usually get the number of H^+ or OH^- right from the formula for the acid or base: $H_{\underline{2}}SO_4$, $H_{\underline{3}}PO_4$, $Ba(OH)_{\underline{2}}$, Na*OH*, etc. Organic acids end with COOH, and only the hydrogens at the end are acidic: CH_3COOH, $C_3H_5O(COOH)_{\underline{3}}$.

Post-lab problem 1: Solid KHP is titrated with aqueous KOH.

$$\frac{\textbf{grams of KHP}}{\textbf{MW of KHP}} \times \mathbf{1} = \mathbf{M_{KOH}} \times \mathbf{V_{KOH}} \times \mathbf{1}$$

You are given the molarity and volume (liters!) of KOH, and you know the molecular weight of KHP, so you just solve for grams of KHP.

Post-lab problem 2: NaOH is neutralized with H_2SO_4. There is 1 OH^- in NaOH and 2 H^+ in H_2SO_4, so the equation looks like this:

$$\mathbf{M_{H2SO4}} \times \mathbf{V_{H2SO4}} \times \mathbf{2} = \mathbf{M_{NaOH}} \times \mathbf{V_{NaOH}} \times \mathbf{1}$$

You are given M_{NaOH}, V_{NaOH}, and M_{H2SO4}, and are solving for V_{H2SO4}. Since both reagents are solutions this time, you can use volumes in mL because the units will cancel.

Post-lab problem 3 uses solid calcium hydroxide, $Ca(OH)_{\underline{2}}$, to neutralize a phosphoric acid solution, $H_{\underline{3}}PO_4$:

$$\mathbf{M_{H3PO4}} \times \mathbf{V_{H3PO4}} \times \mathbf{3} = \frac{\textbf{grams of Ca(OH)}_2}{\textbf{MW of Ca(OH)}_2} \times \mathbf{2}$$

Any acid-base titration/neutralization problem can be done the same way. All of these equations say the same thing – at the equivalence point, moles H^+ = moles OH^-.