VCL 17-7: Analysis of Baking Soda

Titrations provide a method of quantitatively measuring the concentration of an unknown solution. In an acid-base titration, this is done by delivering a titrant of known concentration into an analyte of known volume. (The concentration of an unknown titrant can also be determined by titration with an analyte of known concentration and volume.) Titration curves (graphs of volume vs. pH) have characteristic shapes. The graph can be used to determine the strength or weakness of an acid or base. The equivalence point of the titration, or the point where the analyte has been completely consumed by the titrant, is identified by the point where the pH changes rapidly over a small volume of titrant delivered. In this assignment, you will determine the mass % of an unknown sample of baking soda ($NaHCO_3$) by titrating it with an HCl solution of known concentration.

1. Start *Virtual ChemLab* and select *Analysis of Baking Soda* from the list of assignments. The lab will open in the Titration laboratory. The laboratory will open with a beaker on the stir plate with 1.5000 g of impure solid $NaHCO_3$ and with sufficient water added to make the total volume 25.00 mL. Methyl orange indicator will have also been added to the beaker as well as the calibrated pH meter probe.

2. Click on the *Lab Book* to open it and click on the *Buret Zoom View* window and the pH meter window to bring them to the front. The buret will be filled with 0.3015 M HCl. Click the ***Save*** button in the *Buret Zoom View* window so the titration data be saved. The horizontal position of the orange handle is off for the stopcock. Open the stopcock by pulling down on the orange handle. The vertical position delivers solution the fastest with three intermediate rates in between. Turn the stopcock to one of the fastest positions. Observe the titration curve. When the blue line begins to turn down, double-click the stopcock to turn it off. Move the stopcock down one position to add volume drop by drop.

   There are two methods for determining the volume at the equivalence point: (1) Stop the titration when a color change occurs. Click the ***Stop*** button in the *Buret Zoom View*. A blue data link will appear in the lab book. Click the blue data link to open the *Data Viewer* window. Scroll down to the last data entry and record the volume at the equivalence point in the data table. OR (2) Add drops slowly through the equivalence point until the pH reaches approximately 2. Click the ***Stop*** button in the *Buret Zoom View*. A blue data link will appear in the lab book. Click the blue data link to open the *Data Viewer* window. Click the ***Select All*** button to copy and paste the data to a spreadsheet. Plot the first derivative of pH vs. volume. The peak will indicate the volume at the equivalence point since this is where the pH is changing the most rapidly as the volume changes.

   Unknown sample # __________

   Data Table

mass unknown sample (g)	volume HCl (mL)	molarity HCl (mol/L)

3. *Write a balanced chemical equation for the reaction between $NaHCO_3$ and HCl.*

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4. *Calculate the moles of HCl by multiplying the volume of HCl in liters and the molarity of HCl in mol/L. (Keep four significant digits in all of the calculations.)* ______________________

5. *The moles of HCl can be converted to moles of $NaHCO_3$ using the coefficients from the balanced equation. What is the mole to mole ratio of HCl to $NaHCO_3$? How many moles of $NaHCO_3$ are present in the sample?*

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6. *Calculate the grams of $NaHCO_3$ by multiplying the moles of $NaHCO_3$ by the molecular weight of $NaHCO_3$ (84.007 g/mol).*

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7. The mass % of $NaHCO_3$ present in the sample can be calculated by dividing the mass of $NaHCO_3$ from question #7 by the mass of the sample from the data table and multiplying by 100.

   What is the mass % of $NaHCO_3$?

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