Lab: pH Changes During a Titration

Purpose: To determine the changes in pH of a solution during the titration of a strong acid with a strong base.
To plot and interpret the titration curve obtained from the titration of a strong acid with a strong base.

Introduction:
A computer-interfaced pH Sensor will be placed in the acid solution. A solution of the base will slowly drip from the burette into the acid solution at a constant rate. As the base is added to the acid, you should see a gradual change in pH until the solution gets close to the equivalence point. At the equivalence point, equal numbers of moles of acid and base have been added. Near the equivalence point a rapid change in pH occurs. Also, beyond the equivalence point, when more base has been added than acid, again a very gradual change in pH is observed.
In this experiment you will monitor and plot pH versus time.

Apparatus and Materials:
pH probe, computer, magnetic stirrer, burette with burette stand, beaker, 0.10 mol dm^{-3} $HCl_{(aq)}$, 0.10 mol dm^{-3} $NaOH_{(aq)}$

Procedure:
1. Measure 30.00 mL of 0.10 mol dm^{-3} $HCl_{(aq)}$ in to a beaker, (to fit the pH probe).
2. Add a few drops of phenolphthalein indicator.
3. Fill a burette with 0.10 mol dm^{-3} NaOH and adjust the level to 0.00 mL, record in the data table.
4. Place the pH sensor in the flask, and connect the pH sensor to the computer interface. Wait for a few seconds for the reading to steady. Click on 'Experiment-- Data Collection – Mode: 'events with entry:" Type in 'volume of NaOH', units mL".
5. Prepare the computer for data collection by clicking on 'Data Collection – Start.
6. Click ' Keep' to collect before adding $NaOH_{(aq)}$ to monitor pH for ~5-10 seconds. When the pH reading is steady, type in volume of base initially: 0.00 mL.
7. Now, start adding base from the burette to the acid slowly, while stirring to change the pH by ~ one unit. Stop and record by clicking 'Keep' and record volume of base added to change the pH by ~ one unit.
8. Continue adding base , after each pH change and recording the volume of base added by clicking 'Keep' until and up to a few more mL have been added after the phenolphthalein has changed colour.
9. When you have finished collecting data, click 'Stop'.
10. Print copies of the Data Table and the Graph of pH vs. time at which base was added. (To save data: print screen–copy –paste into paint or save file as Microsoft image or export file, or save file onto your e-mail or in excel, etc.)

Processing the Data:
Use your graph and data table to determine the volume of NaOH titrant added at the equivalence point. Determine the concentration of the base, $NaOH_{(aq)}$.

Discuss the volume at which the pH changes dramatically. What is the pH at this point?

How do the concentrations of hydronium and hydroxide ions compare at this point? What is this point called ?

Why does an acid-base indicator that changes colour at pH 5 or pH 9 work just as well for this reaction as one that changes colour at pH 7 ?

Discuss all weaknesses, limitations, sources of error, and ways to improve the experiment.