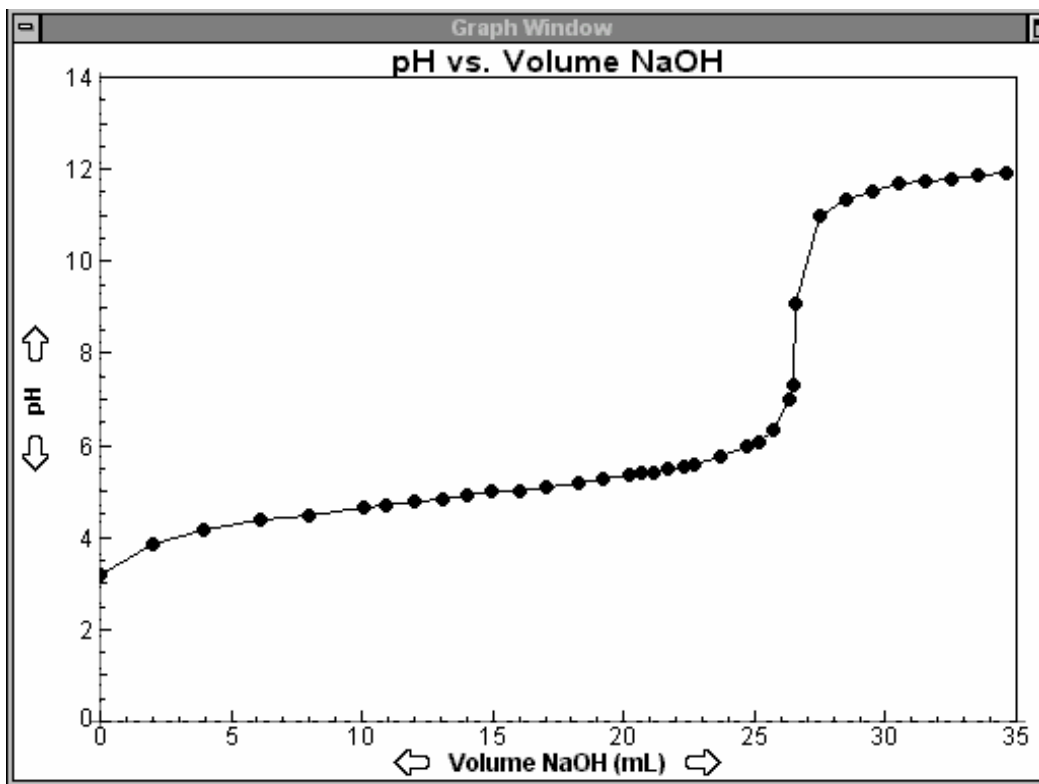


Using Graphical Analysis in Titration Curves

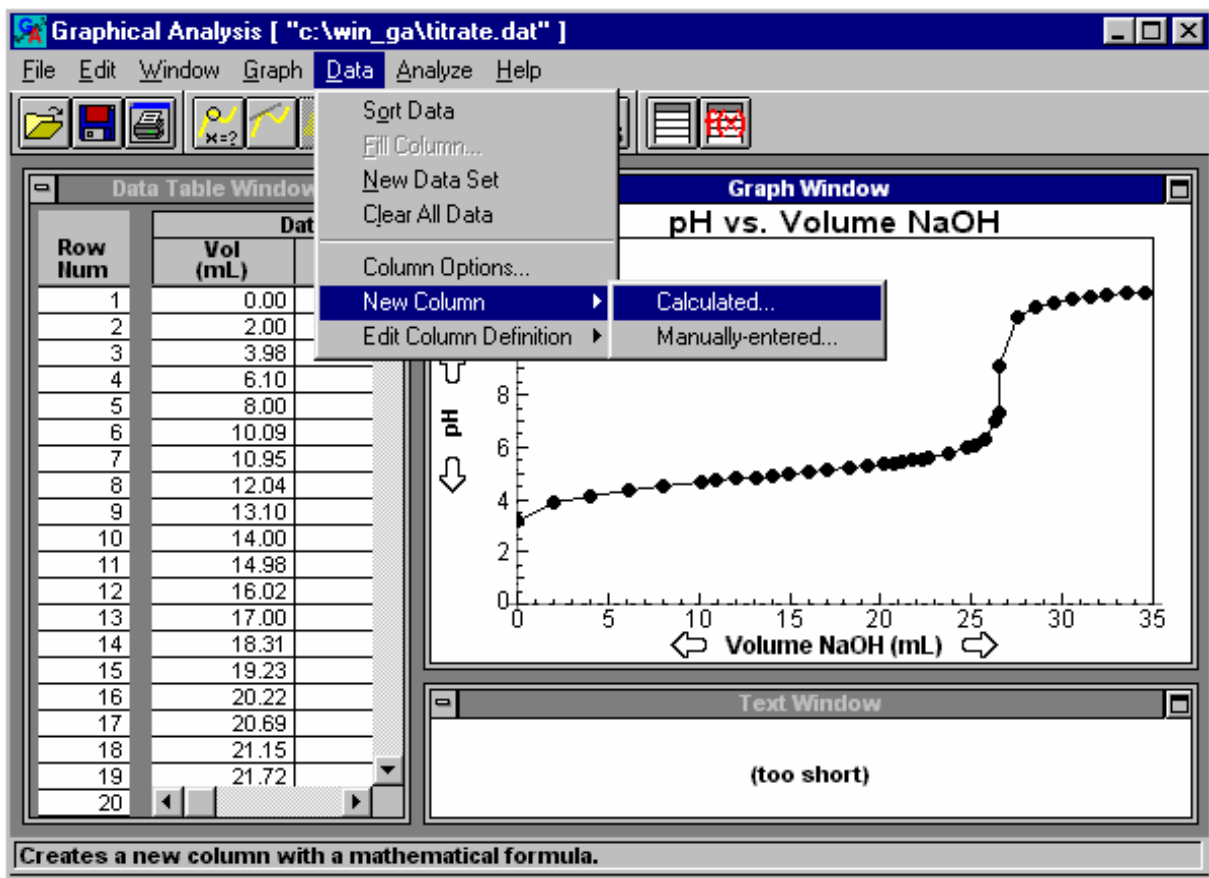
A typical titration curve obtained by plotting the measured pH of a weak acid solution as a strong base is added using graphical analysis for Windows is illustrated as follows:



The equivalence point is halfway up the vertical portion of the curve, about 27 mL for this titration. The pH is about 9 at the equivalence point.

To obtain a better approximation of the volume at the equivalence point, one can do a first derivative plot. This plots the change of pH divided by the change in volume versus the volume of NaOH. This shows the change in slope of the titration curve as a function of the added volume of base.

On the main graphical analysis screen: click on the **data icon**, the **new column field**, and the **calculated field**. The screen will be as follows.



Clicking on the **calculated** box gives the following **New Column** screen..

New Column...

New Column Name: **New Column Units:**

New Column Formula:

exp	ln	10 [^]	log	Columns ▼
sin	cos	tan	row#	Other Functions ▼
sin~	cos~	tan~	^2	
()	^	sqrt	
7	8	9	/	OK
4	5	6	^	Cancel
1	2	3	-	Help
0	.	E	+	

Type in **First Derivative** for the new column name. Click in the **New Column Formula** box to place the cursor there. Then click on **Other Functions**. The screen will be as follows.

The dialog box contains the following elements:

- New Column Name:**
- New Column Units:**
- New Column Formula:**
- Buttons:** exp, ln, 10[^], log, sin, cos, tan, row#, sin[~], cos[~], tan[~], ^2, (,), ^, sqrt, 7, 8, 9, /, 4, 5, 6, *, 1, 2, 3, -, 0, ., E, +
- Dropdowns:** Columns, Other Functions
- Other Functions List:** smooth(), abs(), integral(), derivative(), delta()
- Action Buttons:** Cancel, Help

In the **Other Functions** box, click on the **derivative ()** option, and then click on the **Columns** box. The screen will be as follows.

New Column Name:
First Derivative

New Column Units:

New Column Formula:
derivative()

exp	ln	10 [^]	log
sin	cos	tan	row#
sin~	cos~	tan~	^2
()	^	sqrt
7	8	9	/
4	5	6	*
1	2	3	-
0	.	E	+

Columns ▼

- Volume NaOH
- pH
- Column 3
- Column 4

OK

Cancel

Help

Click on the **pH** option in the **Columns** box. The screen will appear as follows. Now click on the **OK** and you are all set.

New Column...

New Column Name: New Column Units:

New Column Formula:

exp ln 10[^] log Columns

sin cos tan row# Other Functions

sin~ cos~ tan~ ^2

() ^ sqrt

7 8 9 /

4 5 6 ^

1 2 3 -

0 . E +

OK

Cancel

Help

On the original titration curve graph, click on the **pH** label on the vertical axis. The **y-axis setup** screen appears. Click on **first derivative** and click off **pH**. Now click **OK**.

Y-Axis Setup

Choose which columns to plot:

Volume NaOH

pH

First Derivative

AutoScale at 0

Autoscale

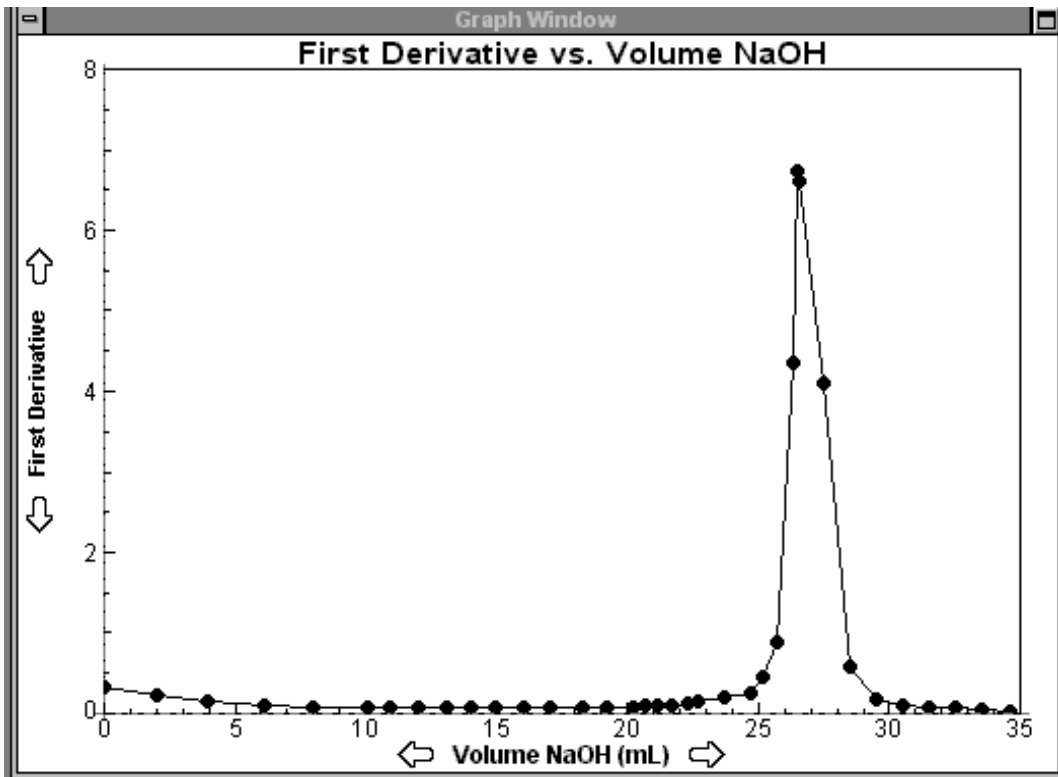
Manual Scaling

Top Limit

Bottom Limit

Ok Cancel Help

The following graph will appear.



The peak at around 27 mL is the equivalence point of the titration.

By clicking on the **pH** label on the vertical axis and clicking on **both the pH and first derivative** options in the **y-axis setup box**, one display both the first derivative and titration plots on one graph as follows.

