

# User's Manual

Win Titration

Version 2.0.2

## Chemical software Acid-base titrations calculator for Windows

Windows XP® - Windows Vista® - Windows 7® - Windows 8® - Windows 10®



## Index

Introduction.....	3
Terms of use.....	3
Description of parts.....	4
Input data window.....	5
Table and results window.....	7
pH Curve window.....	8
Titration examples.....	9
Example 1: Titration of strong acid with strong base.....	9
Example 2: Titration of weak acid with strong base.....	10
Range for input and output values.....	12
Specifications.....	13
Registered trademarks.....	14

## Introduction

Win Titration is a Windows application for acid-base titration calculations.

We can perform strong/weak acid/base titrations choosing the appropriate pH indicator to obtain the table of results and the titration curve.

### ◆ Note

The shown indicator color is approximate.

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## Description of parts

This application has three windows:

### (1) *Input data* window.

Here we can:

Choose the titration type.

Enter the volume and concentration of titrant and analyte

Choose the indicator.

This window is shown when the application starts.

### (2) *Table and results* window.

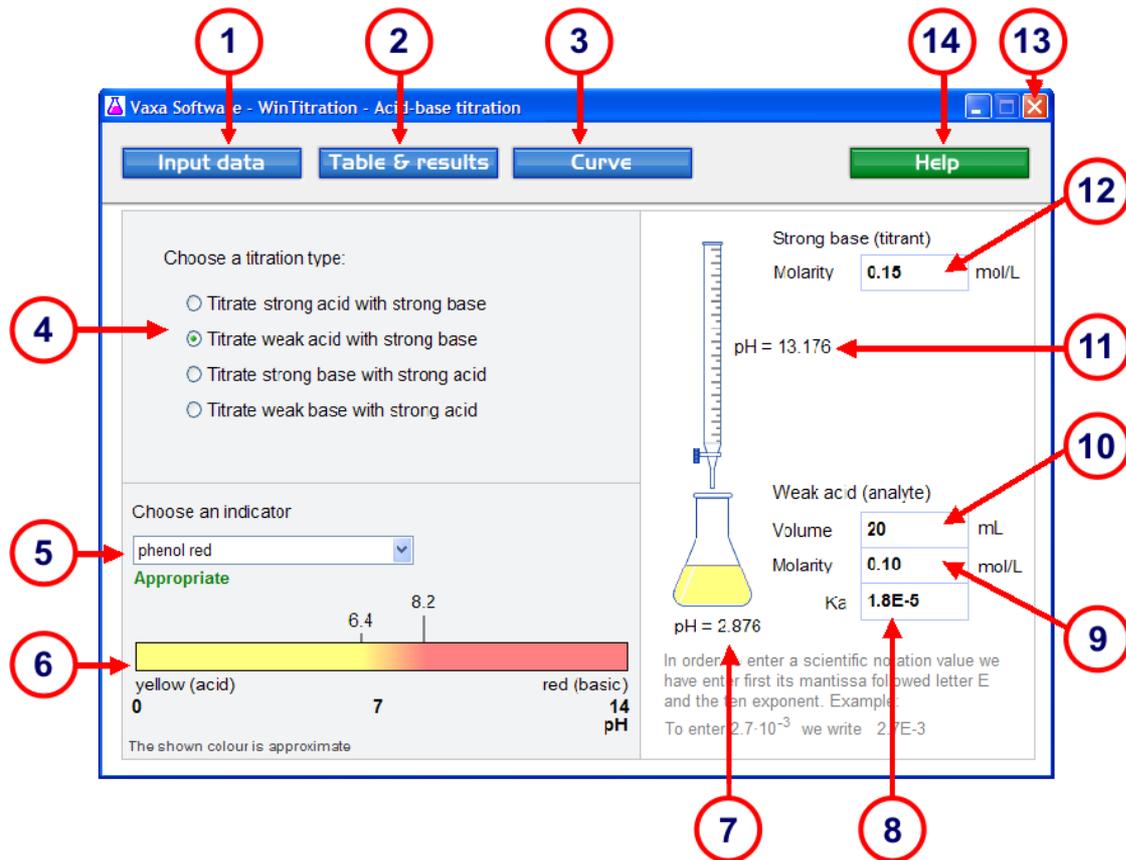
Shows the pH and volume of the equivalence point, range of pH and range of titrant volume when titration error < 1%.

$$\text{Titration Error} = \frac{|\text{current volume added} - \text{volume added at the equivalence point}|}{\text{volume added at the equivalence point}}$$

### (3) *pH curve* window

Shows the graphic of pH versus titrant volume added, equivalence point and color indicator.

## Input data window



**(1) Input data button.**

Shows the *Input data* window.

**(2) Table and results button.**

Shows the *Table and results* window.

**(3) Curve button.**

Shows the *titration curve* window.

**(4) Titration type.**

To select the titration type:

- Titrate strong acid with strong base
- Titrate weak acid with strong base
- Titrate strong base with strong acid
- Titrate weak base with strong acid

**(5) Indicator.**

Allows us to choose the indicator

The indicator color is changed according to pH.

**(6) Indicator color.**

Shows the indicator color in acid and basic environment.

**(7) Initial analyte pH.**

Shows us the initial pH of the analyte. The analyte is contained in an Erlenmeyer flask.

**(8) Acidity/basicity constant of analyte.**

Here we enter the acidity/basicity constant of the analyte ( $K_a$  /  $K_b$ ).

This textbox is shown only if analyte is a weak acid/base.

**(9) Molarity of analyte.**

Here we enter the molarity of the analyte in mol/L.

**(10) Volume of analyte.**

Here we enter the volume of the analyte in mL contained in the Erlenmeyer flask.

**(11) Titrant pH.**

Shows us the pH of the titrant contained in the burette.

**(12) Molarity of titrant.**

Here we enter the molarity of the titrant in mol/L.

**(13) Minimize and Close buttons.**

Allow us to minimize and to close the application.

**(14) Help button.**

Shows us the following menus:

**User's manual (PDF document)... menu**

Shows this manual.

**Application registration... menu**

Shows the registration form window to register the application.

**Disabled functions in the unregistered version menu**

Shows the list of disabled functions when the application is not registered.

**VaxaSoftware home page... menu**

Connects to VaxaSoftware home page.

An active Internet connection and a browser are required.

**About... menu**

Shows the Splash window with the version and description of the application.

## Table and results window

**Titration of weak acid with strong base**

**Titrant (burette):**  
Strong base concentration 0.15 mol/L. pH = 13.18

**Analyte (erlenmeyer flask):**  
20 ml of weak acid Concentration 0.1 mol/l pH = 2.88  
Acidity constant  $K_a = 1.8E-5$

**Equivalence point:**  
Volume added 13.33 mL, pH = 8.762

**Range of added titrant volume when error < 1%**  
[ 13.2 , 13.47 ] mL

**Range of pH when error < 1%**  
[ 10.70 , 6.74 ]

**Indicator:**  
phenol red [appropriate]  
Colour change: yellow (acid) - red (basic)  
pH range: [ 6.4 , 8.2 ]

**Table of values (added Vol. [mL] and pH)**

Vol.	pH
0.00	2.88
2.00	4.00
4.00	4.38
6.00	4.66
8.00	4.92
10.00	5.22
11.00	5.42
12.00	5.70
13.00	6.34
13.10	6.49
13.15	6.60
13.20	6.74
13.25	6.95
13.30	7.35
13.35	9.88
13.40	10.48
13.45	10.72
13.50	10.87
13.55	10.99
14.00	11.47
15.00	11.85

Copy Print

### (15) Titration results.

- **Titration type.**
- **Titrant:** Concentration and pH of titrant acid/base contained in the burette.
- **Analyte:** Volume, molarity, initial pH, acidity/basicity constant.
- **Equivalence point:** Titrant volume added and pH
- **Range of added titrant volume when titration error < 1%**
- **Range of pH when titration error < 1%**
- **Indicator.** Indicator name, Color change acid/basic, pH range.

### (16) Copy button.

Copies the results and table to the clipboard (text format).

### (17) Print button.

Prints the results and table to the default printer.

When the mouse pointer is over the button, the default printer name is shown.

#### Note

To change the default printer we can do it in the *Printers and Faxes* utility in the *Control Panel*.

### (18) Volume versus pH table.

Shows us the titrant volume added in mL versus the pH.

The values are more abundant around the equivalence point (steps of 0.05 mL).

## pH curve window



### (19) pH scale.

Shows us the pH scale in the interval -1 ... 15.

### (20) Titration curve.

Shows the curve of pH vs. titration volume added.

### (21) Titrant volume added scale (mL).

### (22) Curve when titration error < 1%.

This curve is shown in green color.

Here titration error < 1%

The equivalence point is shown as a red circle.

### (23) Print button.

Prints the titration curve to the default printer.

When the mouse pointer is over the button, the default printer name is shown.

### Note

To change the default printer we can do it in the *Printers and Faxes* utility in the *Control Panel*.

### (24) Change of the indicator color.

For each pH value the indicator color is shown.

## Titration examples

### Example 1: Titration of strong acid with strong base.

Calculate the table of results and the titration curve when we titrate 25 mL of hydrochloric acid (HCl) (analyte) of concentration 0.09 mol/L with sodium hydroxide (NaOH) (titrant) of concentration 0.10 mol/L. Indicator is phenolphthalein.

#### Process:

- a) Press the Input data button.
- b) Choose the titration type: *Titrate strong acid with strong base*.
- c) Enter the *Strong base (titrant) Molarity*: 0.10 mol/L.
- d) Enter the *Strong acid (analyte) Volume*: 25 mL.
- e) Enter the *Strong acid (analyte) Molarity*: 0.09 mol/L.
- f) Choose the indicator: phenolphthalein.
- g) Press Table and results button to get the following results:

#### Titration of strong acid with strong base

##### Titrant (burette):

Strong base concentration 0.1 mol/L. pH = 13

##### Analyte (Erlenmeyer flask):

25 mL of strong acid. Concentration 0.09 mol/L. pH = 1.05

##### Equivalence point:

Volume added 22.5 mL, pH = 7

##### Range of added titrant volume when error < 1%

[ 22.27 , 22.72 ] mL

##### Range of pH when error < 1%

[ 10.67 , 3.32 ]

##### Indicator:

phenolphthalein [appropriate]

Color change: colorless (acid) - violet (basic)

pH range: [ 8.2 , 9.8 ]

**Table of values (added Vol. [mL] and pH)**

Vol.	pH	Vol.	pH
0.00	1.05	22.45	3.98
5.00	1.23	22.50	7.00
10.00	1.45	22.55	10.02
15.00	1.73	22.60	10.32
19.00	2.10	22.65	10.50
20.00	2.26	22.70	10.62
21.00	2.49	23.00	11.02
22.00	2.97	24.00	11.49
22.25	3.28	25.00	11.70
22.30	3.37	30.00	12.13
22.35	3.50	35.00	12.32
22.40	3.68	40.00	12.43

h) Press Curve button to see the titration curve.

### Example 2: Titration of weak acid with strong base.

Calculate the table of results and the titration curve when we titrate 20 mL of acetic acid ( $\text{CH}_3\text{COOH}$ ) (analyte) 0.12 mol/L of concentration with sodium hydroxide ( $\text{NaOH}$ ) (titrant) 0.10 mol/L of concentration.

Acidity constant of acetic acid  $K_a = 1.80 \times 10^{-5}$ . Indicator is phenol red.

#### Process:

- Press the Input data button.
- Choose the titration type: *Titrate weak acid with strong base*.
- Enter the *Strong base (titrant) Molarity*: 0.10 mol/L.
- Enter the *Weak acid (analyte) Volume*: 20 mL.
- Enter the *Weak acid (analyte) Molarity*: 0.12 mol/L.
- Enter the *Weak acid (analyte)  $K_a$* : 1.8E-5.
- Choose the indicator: phenol red.
- Press the Table and results button to get the following results:

#### Titration of weak acid with strong base

##### Titrant (burette):

Strong base concentration 0.1 mol/L. pH = 13

##### Analyte (Erlenmeyer flask):

20 mL of weak acid. Concentration 0.12 mol/L. pH = 2.84  
Acidity constant  $K_a = 1.8\text{E-}5$

##### Equivalence point:

Volume added 24 mL, pH = 8.741

##### Range of added titrant volume when error < 1%

[ 23.76 , 24.24 ] mL

##### Range of pH when error < 1%

[ 10.73 , 6.74 ]

**Indicator:**

phenol red [appropriate]

Color change: yellow (acid) - red (basic)

pH range: [ 6.4 , 8.2 ]

**Table of values (added Vol. [mL] and pH)**

Vol.	pH	Vol.	pH
0.00	2.84	23.95	7.42
5.00	4.17	24.00	8.74
10.00	4.60	24.05	10.06
15.00	4.97	24.10	10.36
20.00	5.44	24.15	10.53
21.00	5.59	24.20	10.66
22.00	5.79	25.00	11.35
23.00	6.11	26.00	11.64
23.75	6.72	30.00	12.08
23.80	6.82	35.00	12.30
23.85	6.95	40.00	12.43
23.90	7.12	45.00	12.51

i) Press Curve button to see the titration curve.

## Range for input and output values

Initial concentration $x$ of titrant and analyte	mol/L	$10^{-6} \leq x \leq 10$
Volume $x$ of analyte	mL	$2,5 \leq x \leq 600$
Volume $x$ of titrant at the equivalence point	mL	$5 \leq x \leq 300$
Acidity/basicity constant $x$ ( $K_a$ , $K_b$ ) of analyte		$10^{-14} < x < 1$
pH range $x$ in titration curve		$-1 \leq x \leq 15$
Volume range $x$ of titrant in titration curve	mL	$0 \leq x \leq 600$ Twice the titrant volume at the equivalence point
<i>Appropriate / Inappropriate</i> indicator criterion		An indicator is appropriate when the midpoint of its pH range falls within the interval around the equivalence point where titration error $< 1\%$

## Specifications

<b>Description</b>	<b>Win Titration (WTTR)</b> Windows application for acid-base titration calculations.																												
<b>Precision</b>	Volumes: $\pm 0.01$ mL. Tabulated pH values: $\pm 0.01$ $\pm 0.001$ for titrant pH, Initial analyte pH and Equivalence point pH Internal calculations use 16 digits mantissa.																												
<b>Functions</b>	<b>12 Functions</b> <ul style="list-style-type: none"> <li>- Titrant pH</li> <li>- pH of initial analyte concentration</li> <li>- Titrant + analyte mix pH</li> <li>- Equivalence point pH</li> <li>- Titrant volume at the equivalence point</li> <li>- Range of titrant volume when error &lt; 1%</li> <li>- Range of pH when error &lt; 1%</li> <li>- Indicator color of initial analyte concentration</li> <li>- Indicator color gradient</li> <li>- <i>Appropriate / Inappropriate</i> indicator criterion</li> <li>- pH vs. titrate volume added table</li> <li>- pH vs. titrate volume added curve</li> </ul>																												
<b>Titration types</b>	<b>4 Types</b> <ul style="list-style-type: none"> <li>- Strong acid with strong base titration *</li> <li>- Weak acid with strong base titration</li> <li>- Strong base with strong acid titration *</li> <li>- Weak base with strong acid titration *</li> </ul>																												
<b>Indicators</b>	<b>27 Indicators</b> <table style="width: 100%; border: none;"> <tr> <td style="width: 50%;">alizarin yellow R</td> <td>litmus</td> </tr> <tr> <td>bromophenol blue</td> <td>methyl violet</td> </tr> <tr> <td>bromothymol blue</td> <td>4-dimethylaminobenzol</td> </tr> <tr> <td>phenolphthalein</td> <td>(F) esculin</td> </tr> <tr> <td>m-cresol purple</td> <td>(F) beta-naphthylamine</td> </tr> <tr> <td>methyl orange</td> <td>(F) alpha-naphthylamine</td> </tr> <tr> <td>bromocresol purple</td> <td>(F) fluorescein</td> </tr> <tr> <td>congo red</td> <td>(F) eosin</td> </tr> <tr> <td>bromophenol red</td> <td>(F) eritrosine</td> </tr> <tr> <td>cresol red</td> <td>(F) acridine</td> </tr> <tr> <td>phenol red</td> <td>(F) umbelliferone</td> </tr> <tr> <td>methyl red</td> <td>(F) coumarin</td> </tr> <tr> <td>neutral red</td> <td>(F) beta-methylumbelliferone</td> </tr> <tr> <td>thymolphthalein</td> <td></td> </tr> </table>	alizarin yellow R	litmus	bromophenol blue	methyl violet	bromothymol blue	4-dimethylaminobenzol	phenolphthalein	(F) esculin	m-cresol purple	(F) beta-naphthylamine	methyl orange	(F) alpha-naphthylamine	bromocresol purple	(F) fluorescein	congo red	(F) eosin	bromophenol red	(F) eritrosine	cresol red	(F) acridine	phenol red	(F) umbelliferone	methyl red	(F) coumarin	neutral red	(F) beta-methylumbelliferone	thymolphthalein	
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methyl red	(F) coumarin																												
neutral red	(F) beta-methylumbelliferone																												
thymolphthalein																													
<b>Size</b>	781 pixels x 580 pixels																												
<b>Notes</b>	( * ) Only available in the registered version (F) Fluorescent indicator																												

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