Robotic Transfer Analyzer

Applications

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Metrohm
Ion analysis

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Symbols used in this document:

c (X)	Molar concentration of substance X in mol/L, often written as [X]
M (X)	Molar mass of substance or atomic mass (relative mass) of substance X in g/mol
w (X)	Mass fraction of substance X, e.g. w (NaOH) = 40%
ß (X)	Mass concentration of substance X, e.g. ß(NaCl) = 20 g/L
a (X)	Activity of substance X (only corresponds to the molar concentration in very diluted solutions; as the concentration increases, dissolved particles mutually influence each other so that their activity is lower than would be expected from the concentration).
pK_p	Autoprotolysis constant of a solvent
{ }	In this document braces such as used in the formula {AgCl} indicate solid substances (precipitates) that do not consist of single molecules (in this case AgCl), but whose ionic components form an extended ionic lattice.

tiamo methods

The methods described in this document are part of the *tiamo* installation on your PC system. To use these methods you can import them into your method groups with the built-in method manager in the *tiamo* software. Please consult the *tiamo* user manual or online-help for further instructions.

The methods can be found in the following path:

C:\Program Files\Metrohm\tiamo\examples\methods\english\855 Robotic Analyzer\Transfer

(The *tiamo* installation path of your system may be different.)

The *tiamo* user manual (in pdf file format) can be found in the following path:

C:\Program Files\Metrohm\tiamo\doc\English

Accessories of the Robotic Transfer Analyzer

1.855.0020	Robotic Titrosampler 1T/2P-V
1.800.0010	Dosino, 2x
1.802.0010	Rod Stirrer
1.804.0010	Ti Stand
6.0253.100	LL-Aquatrode plus OK
6.1414.060	Micro titration vessel lid ECO
6.1415.220	Titration vessel
6.1432.320	Sample beaker 250 mL
6.1462.040	Robotic arm (transfer)
6.1543.120	Aspiration tip M8
6.1546.030	Piston rod
6.1562.120	Pipetting tube 10 mL, with holder
6.1608.023	Bottle 1 L, 2x
6.1621.000	PE container 10 L, 2x
6.1805.060	FEP tubing / M6 / 60 cm, 3x
6.1805.120	FEP tubing / M6 / 100 cm
6.1805.510	PTFE tubing M8, 60 cm
6.1812.000	PTFE tubing 4/6 mm, 4m
6.1815.010	Spiral band 0.5 m
6.1823.010	Guiding shaft to Pipetting tubing
6.1828.000	PVDF connection nipple, 2x
6.1909.020	Stirring propeller 104 mm
6.2001.070	Support stand
6.2001.110	Bottle holder base, left side
6.2013.010	Clamping ring, 2x
6.2041.410	Sample rack 141 x 11 mL + 1 x 500 mL
6.2053.000	Cable clip, 10x
6.2061.010	Bottle holder
6.2104.020	Electrode cable 1 m
6.2151.000	Cable USB A - mini-DIN 8P
6.2308.050	KCl solution 3 mol/L (50 mL)
6.2323.000	Storage solution
6.2621.030	Hexagon key 4 mm
6.2621.070	Hexagon key 5 mm
6.2621.130	Hexagon key 2 mm
6.2621.140	Hexagon key 2.5 mm
6.2709.090	Stopper 12 mm, 2x

6.2711.070	Drip pan
6.2730.030	Stopper with nipple M10, 5x
6.2730.060	Screw nipple M16/12 mm, 2x
6.2730.080	Screw nipple M16/SGJ14
6.2740.020	Spray nozzle, 3x
6.2743.057	Sample tubes 11 mL/200 pieces, 2x
6.3032.210	Dosing Unit 10 mL
6.3032.220	Dosing Unit 20 mL
6.6056.112	*tiamo* 1.1 full version CD
E.3010.022	O-rings 5,28/1,78, 5x
T.2400.102	Ferrite cores, 4x

Table of content

1 Application Information

1.1 Introduction: titration means counting!

- Titrations are easy to carry out: The equipment and the procedures to be performed are simple. They are easy to understand – the fundamentals of titrimetric methods are widely known or can be learned in a short time.
- Titrations are carried out rapidly: If the total time for setting up the workplace to obtaining the analytical result is taken into consideration, then titrimetric determinations require much less time than other methods.
- Titration is a versatile method: Numerous titration methods have been drawn up, these range from the determination of inorganic ions up to the determination of complex organic compounds. The analyte concentrations can range from 100% or virtually 100% (analysis of ultrapure substances, purity determinations) down to the ppm range. Sample amounts of a few micrograms are adequate, amounts in the gram range are also possible.
- Titration supplies highly reproducible and correct results. A typical reproducibility is <1%. In high-precision titrations values of 0.1% are demanded and also achieved. For such demands the accuracy should lie within the limits of the standard deviation.
- Titrations can be automated: Titrimetric determinations can be automated to a high degree. This means that, for example, they are suitable for analyzing the content in routine operation (e.g. active ingredient content in tablets).

1.2 Acid / Base reactions

The term acid-base has been revised several times since the 18th century in accordance with the state of knowledge:

- Acids contain oxygen (Lavoisier)
- Acids contain hydrogen that can be replaced by a metal (Liebig)
- Acids dissociate in aqueous solution to release protons and bases release hydroxide ions (Arrhenius, Ostwald)

These theories can only partly explain chemical reactions. They refer to aqueous solutions; ampholytes are not included. Examples are aqueous solutions of salts: $KHSO_4$ reacts acidic, Na_2HPO_4 alkaline.

Brønsted defined the acid-base reaction as the exchange of protons. The *acid* acts as *proton donor* and the *base* as *proton acceptor*. A deprotonated acid is called the conjugate base and a protonated base is called the conjugate acid. In this way the theory can also be applied without any problem to ampholytes, salts and prototropes of non-aqueous solvents. The equilibrium constants of the reactions allow a quantitative reactivity series of acids and bases to be drawn up (see below).

Lewis extended the Brønsted theory (Brönsted theory). A Lewis base has a free electron pair, a Lewis acid an electron pair gap. Lewis acid and Lewis base react to form a covalent or coordinative compound. Examples:

$$2\ CN^- + Ag^+ \longrightarrow [Ag(CN)_2]^-$$

$$2\ Cl^- + SnCl_4 \longrightarrow [SnCl_6]^{2-}$$

Typical Lewis acids are molecules with an incomplete valency shell, cations as the central atoms of complexes and molecules with multiple polar bonds (e.g. acid anhydrides). Typical Lewis bases are molecules and ions with free electron pairs, anions as complex ligands and molecules with multiple bonds. The Lewis model can also be used to describe precipitation and complex-forming reactions. As no universal reference acid or base exists, there is no

practical quantitative reactivity series for Lewis acids and bases; however, the Lewis conception allows numerous chemical reactions to be systemized qualitatively.

Protolysis

Polar (prototropic, protic) solvents undergo self-dissociation, i.e. they form an acid-base pair to a slight extent.

Example water:

$$2\ H_2O \rightleftharpoons H_3O^+ + OH^-$$

Neither free protons nor free electrons are found in a solution. For protons this means that H^+ should not be used as an expression, but rather H_3O^+ to represent the clusters of protons and water effectively present in an aqueous solution.

According to the law of mass action, the ionic product of water $\mathbf{K_w}$ is calculated as follows:

$$a(X^+) \times a(Y^-) / a^2(XY)$$

for H_2O this means:

$$a(H_3O^+) \times a(OH^-) / a^2(H_2O)] = K_W = 10^{-14}$$

K is temperature-dependent. In tables it is usually given for 25 °C (the values for H_2O are 14.9 at 0 °C, 14.2 at 20 °C, 14.0 at 25 °C, 13.5 at 40 °C, etc.).

The relative «strength» of an acid or base in an aqueous solution is described by the equilibrium constants. These provide information about the extent to which an acid or base dissolved in water at equilibrium can accept or donate protons. Water is the reference base for each acid and the reference acid for each base. These acidity and basicity constants are known as $\mathbf{K_a}$ and $\mathbf{K_b}$ respectively. We have simplified their formulation here by using the molar concentration instead of the activities of the participating species. The molar concentration of water in a mixture is regarded as being constant for diluted solutions (55.5 mol/L) and not included.

$$K_a = [H_3O^+] \times [A^-] / [HA]$$

$$K_b = [BH^+] \times [OH^-] / [B]$$

The negative common logarithms of these values are, analogous to the pH definition, known as $\mathbf{pK_a}$ and $\mathbf{pK_b}$ respectively. The higher the pK value, the weaker the acid or base.

The neutral point of a non-aqueous solvent is calculated in a similar manner to that for water. Clearly, the pH term only applies to purely aqueous solutions!

$$H_2O, \text{neutral pH} = -\log\sqrt{K_W} = -\log\sqrt{10^{-14.0}} = +7.0$$

The following table shows a small selection of autoprotolysis constants of prototropic solvents (at 25 °C).

Solvent	Autoprotolysis			pK_p
Ethanol	$2\ C_2H_5OH$	$\rightleftharpoons$	$C_2H_5OH_2^+ + C_2H_5O^-$	19.1
Methanol	$2\ CH_3OH$	$\rightleftharpoons$	$CH_3OH_2^+ + CH_3O^-$	16.7
Acetic acid	$2\ CH_3COOH$	$\rightleftharpoons$	$CH_3COOH_2^+ + CH_3COO^-$	14.5
Water	$2\ H_2O$	$\rightleftharpoons$	$H_3O^+ + OH^-$	14.0
Formic acid	$2\ HCOOH$	$\rightleftharpoons$	$HCOOH_2^+ + HCOO^-$	6.2
Sulfuric acid	$2\ H_2SO_4$	$\rightleftharpoons$	$H_3SO_4^+ + HSO_4^-$	3.6

Acid-base reactions with water

In aqueous solutions the protolysis reaction with water normally predominates (as an ampholyte H_2O can act as a Brønsted acid or a Brønsted base):

acidic reaction of solvent

$$HB\ (a)\ +\ H_2O\ (b) \rightleftharpoons H_3O^+\ +\ B^-$$

basic reaction of solvent

$$B^-\ (b)\ +\ H_2O\ (a) \rightleftharpoons HB\ +\ OH^-$$

Just as with the ionic product of water, a(solvent) is set = 1 for dilute solutions. The resulting equilibrium constants are known as the *acidity constant* $\mathbf{K_a}$ and the *basicity constant* $\mathbf{K_b}$.

$$K_a \times K_b = K_w$$

$$pK_a + pK_b = pK_w = 14\ (25\ °C)$$

The stronger the acid or base, the weaker the conjugate base or acid.

At the same time the pK values of the aqueous system limit the acidic or basic strength of protolytes in aqueous solution (differentiation).

Stronger acids and bases (pK <0 or pK >14 for the conjugate protolyte) are converted to oxonium ions (H_3O^+) and hydroxide ions (OH^-) in aqueous solution. *Leveling* occurs – the separate determination of mixed very strong acids or mixed very strong bases in an aqueous solution is not possible by titration. (Only one endpoint is found in the titration of mixtures of e.g. KOH/NaOH or HCl/H_2SO_4).

The known corresponding acid-base pairs are arranged according to increasing pK_a (or decreasing pK_b value) and normally divided into the following categories:

- very strong pK_a <0
- strong pK_a 0…4
- weak pK_a 4…10
- very weak pK_a 10…14
- extremely weak pK_a >14

Protolytes

As a result of the leveling effect of water, differences in the protolysis constants of strong protolytes can only be determined in non-aqueous solvents. In such solvents the relationship $pK_a + pK_b = pK_{solvent}$ also applies for the conjugate acid-base pair. This means that the solvent cation (*lyonium ion*) and the solvent anion (*lyate ion*) are always the strongest acids and bases in the affected system.

Whereas acetic acid behaves in water like a weak acid, in $HClO_4$ it behaves like a base:

$$CH_3COOH\ +\ H_2O \rightleftharpoons H_3O^+\ +\ CH_3COO^-$$

$$HClO_4\ +\ CH_3COOH \rightleftharpoons CH_3COOH_2^+\ +\ ClO_4^-$$

In order to be able to achieve the separate determination of the components in an aqueous solution by titration, the differences in their pK values should be approx. 5 units. In contrast, in suitable non-aqueous solvents a difference of 2 to 3 pK units is normally sufficient.

pK_a values of some selected acids

Acids	pK_a
Acetic acid	4.73
Acrylic acid	4.26
Benzoic acid	4.20
Boric acid	9.24
Chloroacetic acid	2.81
Hydrobromic acid	≈ –6
Hydrochloric acid	≈ –3
Hydrocyanic acid	9.40
Hydrofluoric acid	3.14
Hydrogen sulfide acid 1st stage	6.90
Hydrogen sulfide acid 2nd stage	12.9
Lactic acid	3.86
Nitric acid	1.32
Oxalic acid 1st stage	4.31
Oxalic acid 2nd stage	1.42
Perchloric acid	≈ –9
Phenol	9.95
Phosphoric acid 1st stage	1.96
Phosphoric acid 2nd stage	7.12
Phosphoric acid 3rd stage	12.36
Salicylic acid	2.98
Sulfuric acid 1st stage	≈ –3
Sulfuric acid 2nd stage	1.92

pK_b values of some selected bases

Bases	pK_b
2-Picoline	7.52
Acridine	9.89
Ammonia	4.75
Aniline	9.42
Benzylamine	4.62
Calcium hydroxide	1.30
Coffeine	13.39
Cyclohexylamine	3.36
Diethanolamine	5.12
Ethanolamine	4.56
Ethylamine	3.33
Imidazole	7.00
Lithium hydroxide	–0.10
Magnesium hydroxide	3.36
Naphthylamine	10.08
o-aminobenzoic acid	10.92
o-toluidine	9.61
Piperidine	2.80
Pyridine	8.81
Triethanolamine	6.23
Triethylamine	3.28
Trimethylamine	4.20
Urea	13.8

The strongest acid in the list is perchloric acid, the strongest base is lithium hydroxide.

The following empirical rules apply for the *relative acid strength* of inorganic acids:

- *Hydracids*: the acidity increases as the atomic number increases, both within the group and within the period. (This means that HI is the strongest acid.):

  $HF < HCl < HBr < HI$

- *Oxyacids* are stronger the fewer H atoms and more O atoms they contain. (The strongest mono-oxyacid is $HClO_4$).

  $HClO < HClO_2 < HClO_3 < HClO_4$

  $H_4SiO_4 < H_3PO_4 < H_2SO_4 < HClO_4$

1.3 Acid-base titrations

Acid-base reactions occur very rapidly (proton transfer takes far less then one millionth of a second).

In mixtures of acids the titration is always carried out in the sequence of the relative acid strengths. This means that the strongest acid is always titrated first, the weakest acid last.

Example:

The titration curve of a mixture of HCl and CH_3COOH shows two equivalence points/endpoints. The consumption up to EP1 corresponds to the molar concentration of HCl and the consumption for the difference EP2 – EP1 to the molar concentration of acetic acid.

Titration of strong protolytes (strong acid with strong base and vice versa)

The salts of strong acids with strong bases do not undergo protolysis with water, which means that an equivalent amount of these acids and bases react neutrally. The equivalence

point in the titration of a strong acid with a strong base and vice versa is therefore identical with the neutral point (pH = 7.0 in H_2O).

The shape of the titration curve results from the fact that in order to increase the pH from 1 to 2 it is necessary to reduce the H_3O^+ concentration to 1/10 of the original value (or that 90% of the equivalent base has already been added). From pH = 2 to pH = 3 it is then 9%, from pH = 3 to pH = 4 then 0.9%, etc. With the excess base it is exactly the opposite; from pH = 7 to pH = 8 0.0009% is necessary, from pH = 8 to pH = 9 requires 0.009%, from pH = 9 to pH = 10 it is 0.09% excess base, etc.

This is why typical symmetric titration curves with a steep «jump region» are obtained, whose equivalence point (titration endpoint, corresponds to the point of inflection of the curve) lies at pH = 7.0.

Titration of a weak acid with a strong base

Before the start of the titration it can be seen that the pH is acidic, which corresponds to the weak acid not being completely dissociated in water. After the start of the titration a buffering range (10...90% of neutralization) can be observed in which the weak acid and its salt or acid anion are both present. In this buffering range the addition of the base only alters the pH slightly. The point of inflection of the buffering range corresponds to the semi-equivalence point of the titration (half reaction) and therefore, according to the Henderson-Hasselbalch equation, the pK_a value of the weak acid is given by: $pH = pK_a + \log [A^-] / [HA]$, where at half reaction the molar concentrations of acid anion and acid are equal – resulting in log 1, which is equal to 0.

In the above case the equivalence point no longer lies at pH = 7, because the added base competes with the conjugate base of the acid. At the equivalence point the *salt solution* present has an *alkaline* reaction, as the acid anions of a weak acid undergo protolysis with water (hydrolysis). The equivalence point of such a titration lies – depending on the relative strength of the acid – in the pH range 7.5...10.

The higher the concentration of acid and base in the solution, the wider the buffering range on the volume axis. The pH value achieved by adding additional base beyond the equivalence point finally approaches that of the base used as the titrant.

Titration of a weak base with a strong acid

Before the start of the titration an alkaline pH is measured that corresponds to that of the not fully dissociated weak base in water. After the start of the titration a buffering range can also be observed (10...90% of the neutralization), in which the weak base and its conjugated protonated form are both present. Addition of acid hardly alters the pH in this buffering range at all. The point of inflection of the buffering range corresponds to the semi-equivalence point of the titration (half reaction) and lies at that pH value which corresponds to the pK_b value of the base. The equivalence point is again no longer at pH = 7, because the added acid competes with the conjugate acid of the base. The corresponding salt solution is acidic as the protonated base undergoes protolysis with water (hydrolysis). The equivalence point lies – depending on the relative strength of the base – in the pH range 6.5...4.

Titration of a weak acid with a weak base

This titration is unsuitable for quantitative determinations! There is no marked jump in the titration curve, and the slope of the curve in the equivalence region does not achieve a maximum value. No suitable titration endpoint for a quantitative determination is reached. This means that, when selecting a titrant for the titration of weak acids and bases, weak bases and acids should not be chosen.

Titration curve

The following applies in general: The «jump» of a titration curve is more marked the higher the K_a or K_b values of the two reaction partners and the higher the concentrations of both species.

1.4 Introduction to pipetting sequences

Pipetting equipment

Together with an 800 Dosino as dosing drive (or "pipetting pump"), the Sample Processor is exceedingly suitable for pipetting liquids in a volume range from 0.5 to 9.5 mL.

Pipetting procedure

Basic principles

Measuring out the liquid to be pipetted takes place in a pipetting tubing filled with a carrier liquid (preferably water). In order to prevent any carryover or mixing an air bubble (air gap) must be inserted between the sample and the carrier liquid.

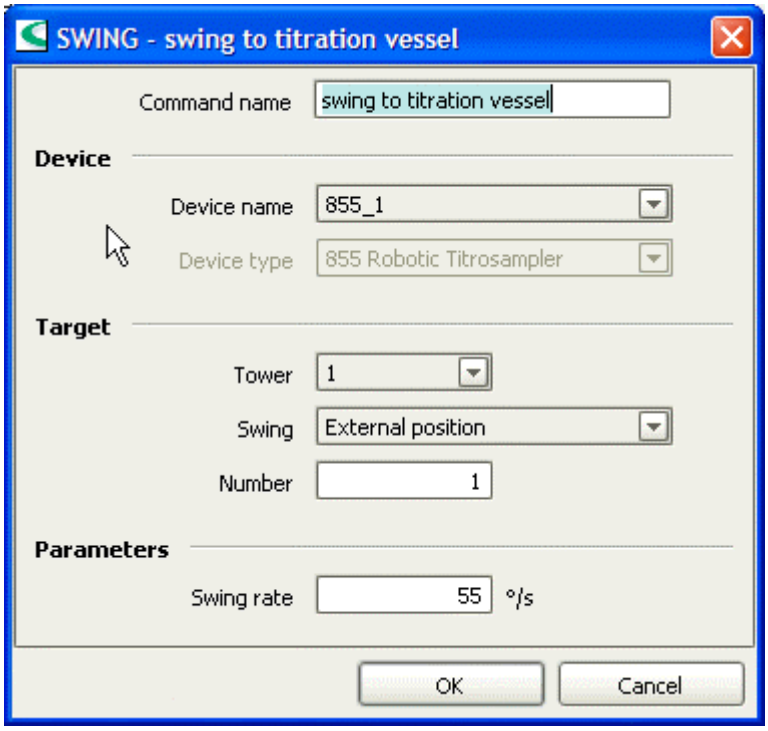
A Dosino drive is used to transfer the liquids into the pipetting tubing. The pipetting tubing is connected to Port 1 of the Dosing unit. The Dosing unit is mounted on a reagent bottle containing the carrier liquid. This can be refilled via filling port 2 of the Dosing unit. The carrier liquid can also be used for rinsing and diluting the sample.

Various pipetting procedures are possible. The following conditions must always be observed:

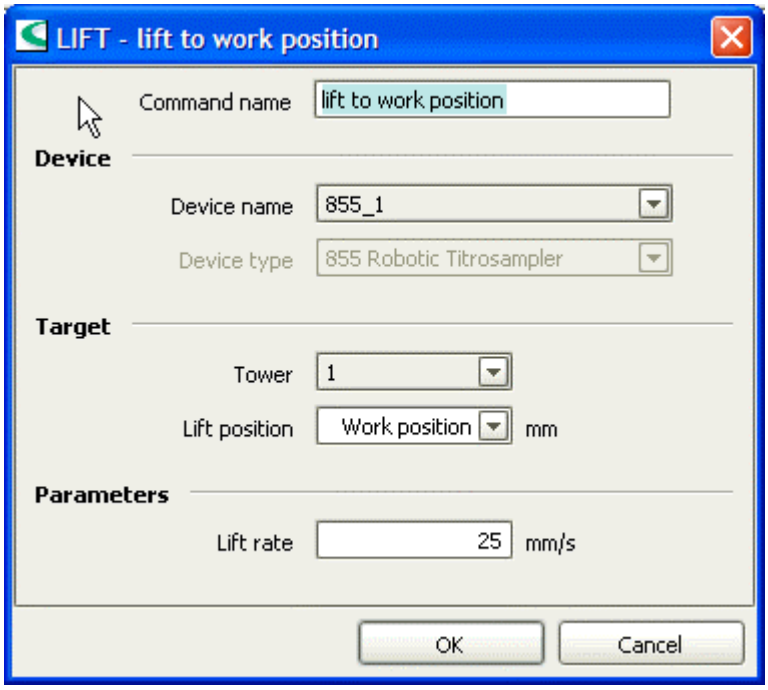
- The sample must always be measured out in the pipetting tubing; it must never enter the Dosing unit cylinder.
- The sample should always be aspirated after the dosing cylinder has been ejected.
- The difference in level between the surface of the sample liquid and that of the carrier liquid in the cylinder should be as small as possible.
- Aqueous sample solutions can be pipetted without having to rinse the tubing. Non-aqueous samples require the pipetting tubing to be rinsed with carrier liquid (same solvent as the sample), to avoid carryover.

Preparing the Dosing unit and the titration vessel

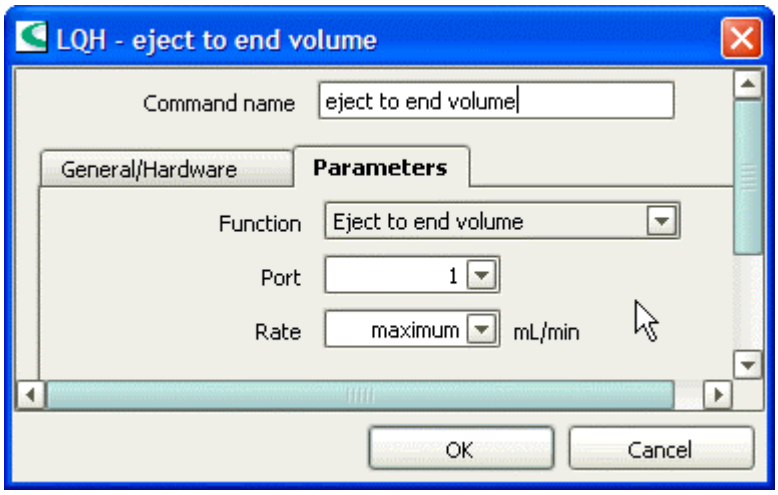
The Dosing unit must first be prepared, i.e. the filling tubing and pipetting tubing must be rinsed and completely filled. The cylinder contents must then be ejected.



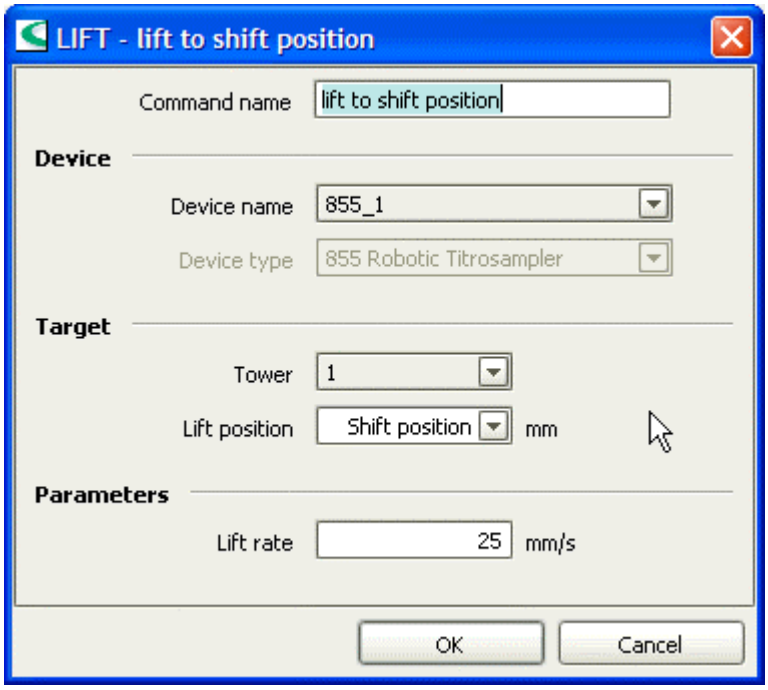
The robotic arm is moved to the external titration vessel.



The robotic arm is lifted down to the work position where a preparation command for the Dosino is executed.



After the preparation step the complete cylinder content is ejected to end volume using Port 1. Then the tower is lifted to shift position.



These steps should be carried out before every sample series involving pipetting. Before each pipetting process the Dosing unit cylinder contents must be completely ejected. This is the only way to achieve reproducible, accurate pipetting.

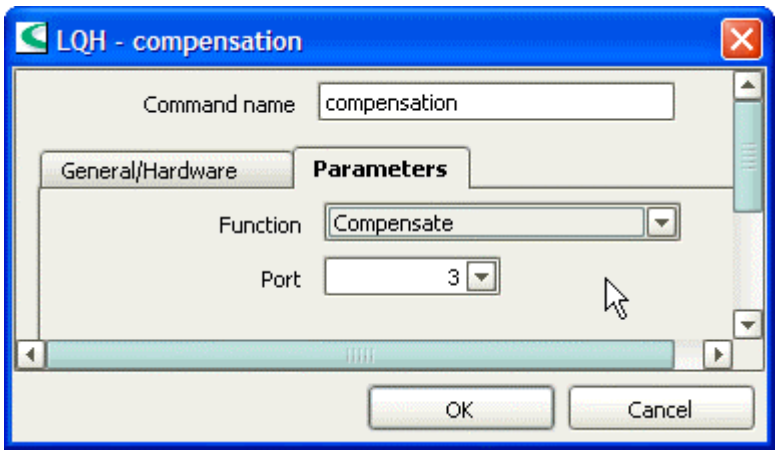
The titration cell can then be aspirated, rinsed and prepared with fresh solvent.

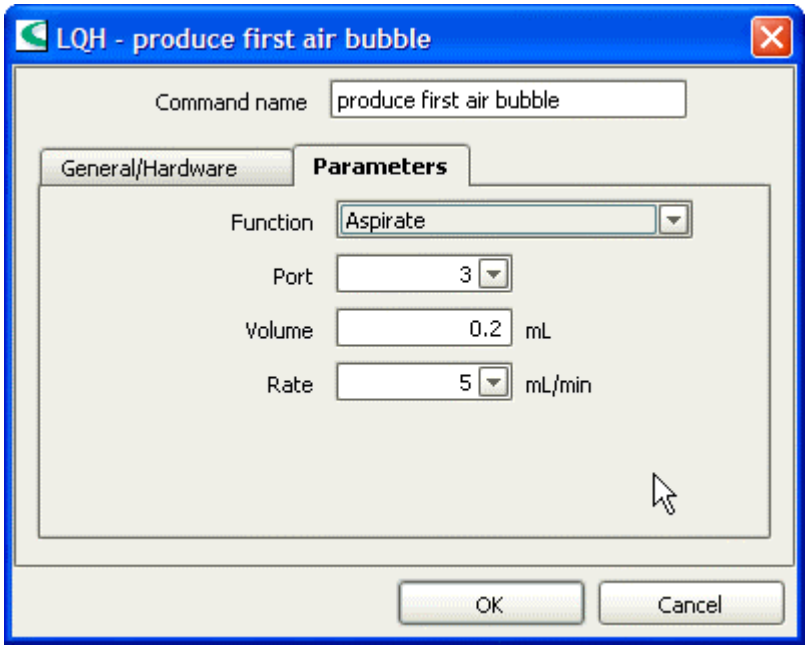
Pipetting

The pipetting procedure takes place in five steps:

- Ejection of cylinder contents (see above) and formation of separating bubble
- Move to sample
- Aspirate / Measure out sample
- Move to target
- Eject sample

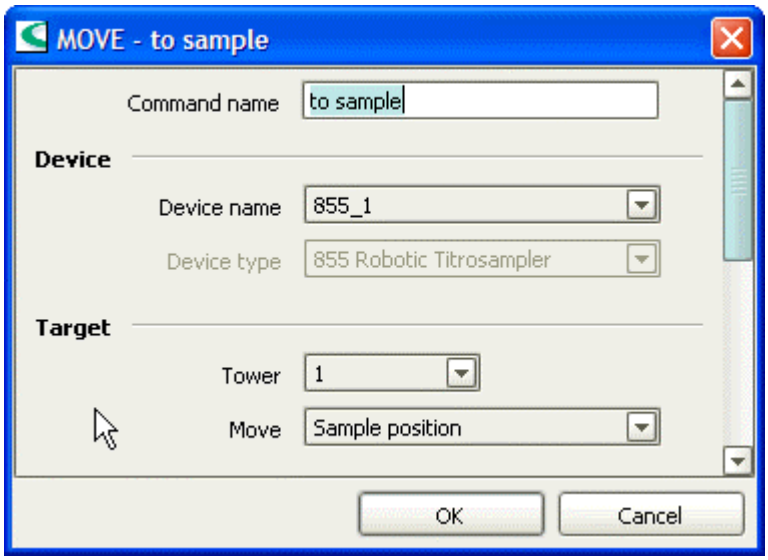
Formation of separating bubble (air gap)



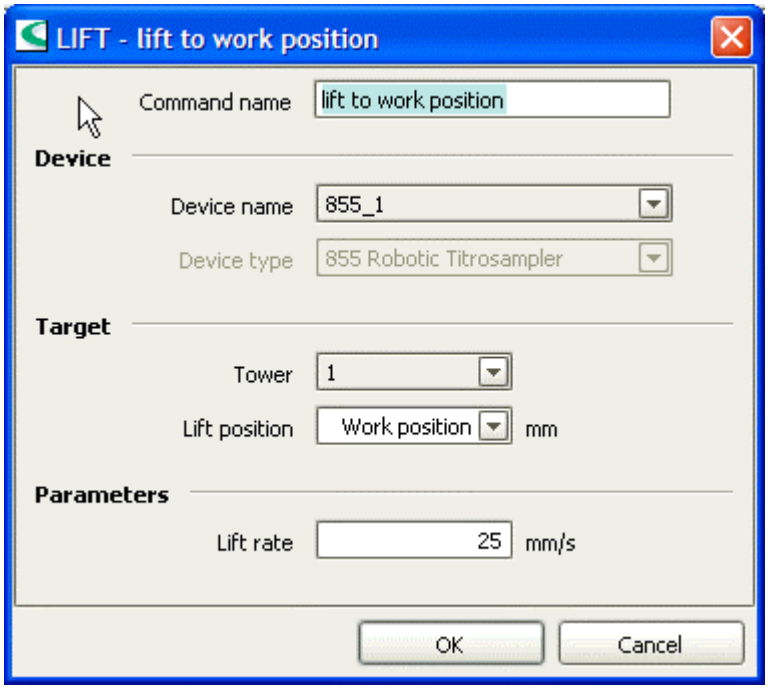


In order to prevent the carrier liquid and the sample solution from mixing, a separating air bubble must be formed that occupies a length of at least 5 mm in the pipetting tubing. However, the separating air bubble must also be measured out with sufficient accuracy. This is why a Dosing unit with max. 10 mL cylinder capacity should be used for pipetting.

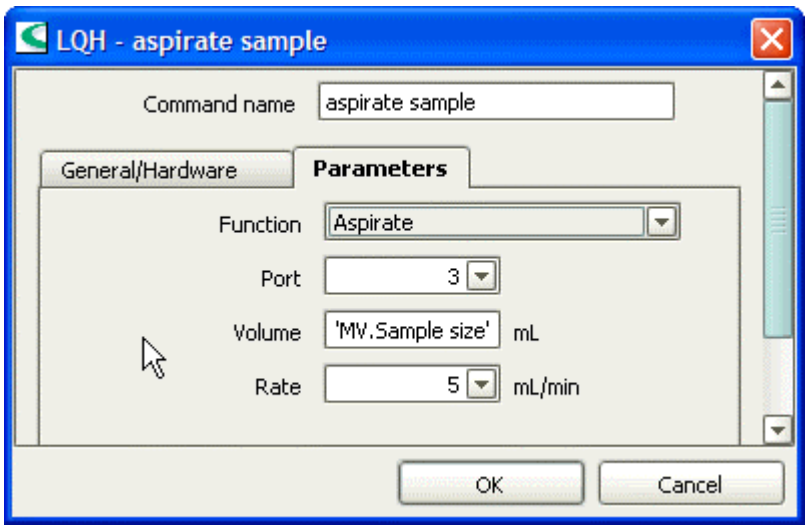
Move to sample



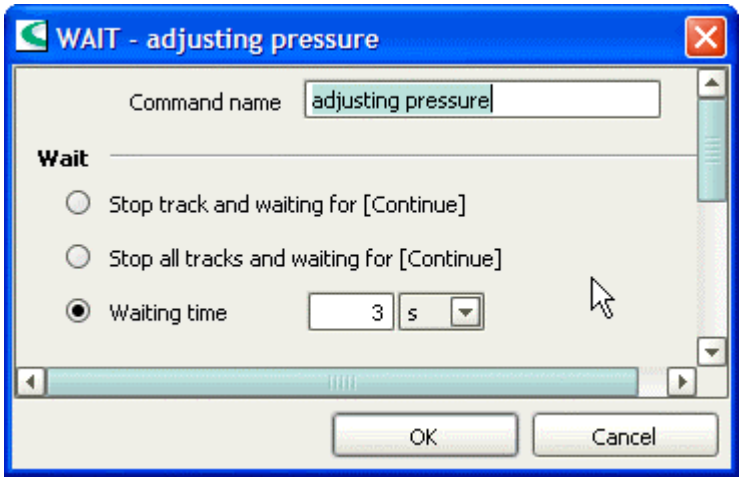
The robotic arm is then moved to the sample position.



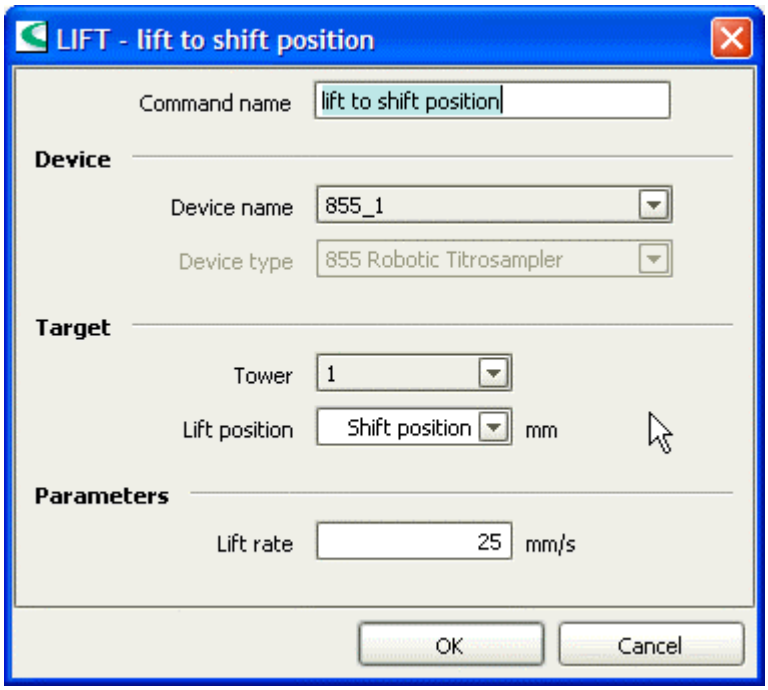
Aspirate sample

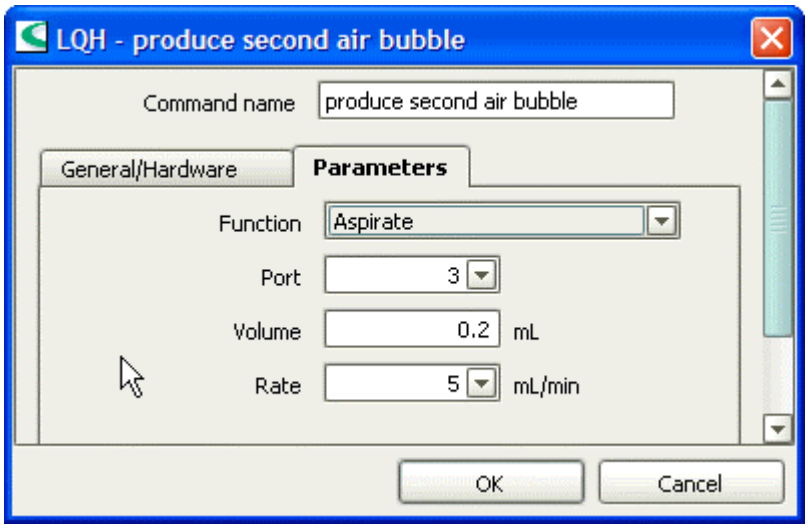


Aspiration of the sample should be carried out at a reduced filling rate (<10 mL/min).



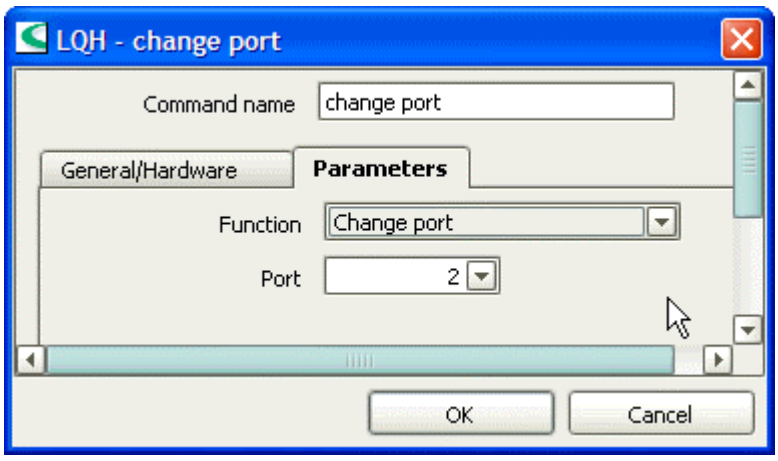
The system needs approximately 3 seconds for adjusting the pressure after the aspiration step. The waiting time can vary depending on the sample properties.



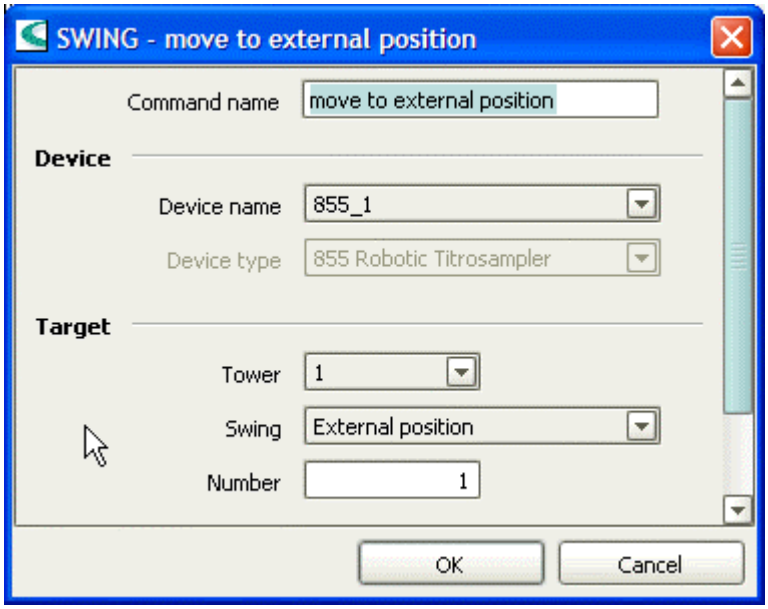


Especially with non-aqueous samples an additional small air bubble may be drawn into the pipetting tip in order to prevent the sample solution from dripping when moving from sample beaker to the titration vessel.

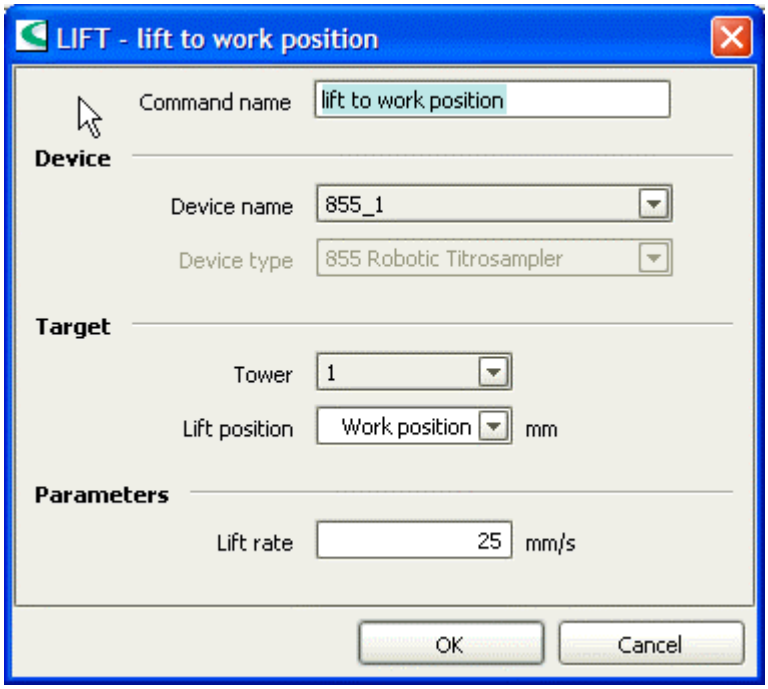
Move to target



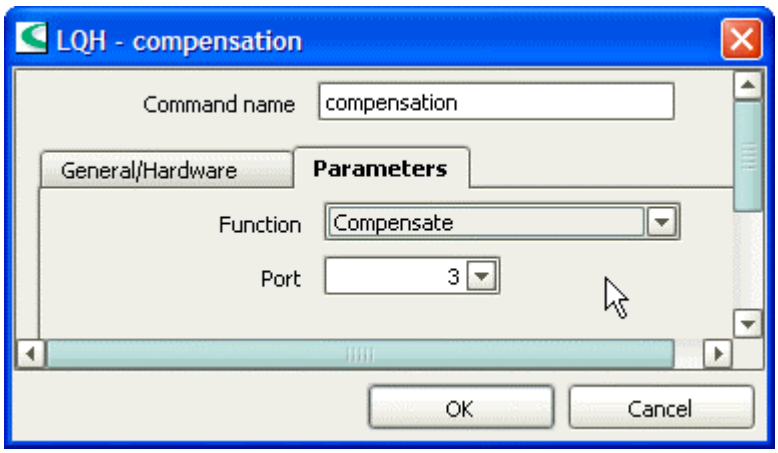
Before the pipetting tubing containing the measured out sample is moved, the corresponding Dosino port must be closed.

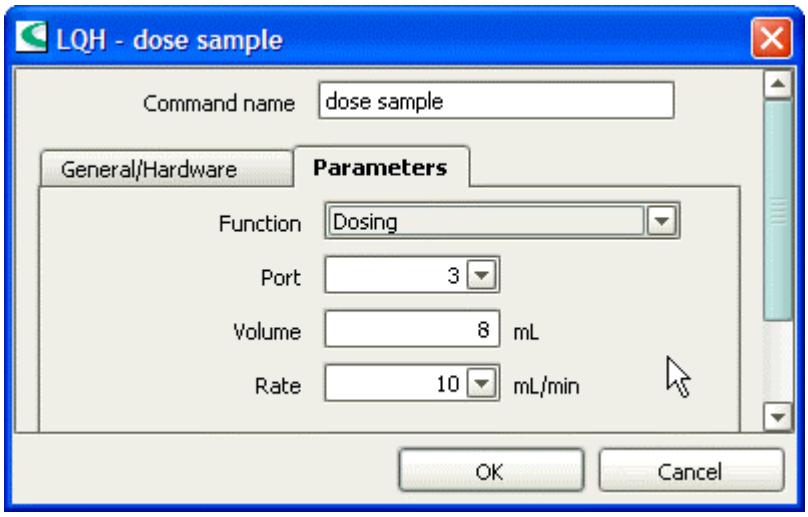


The titration cell should be filled with solvent before the sample is added so that the sample can be pipetted directly into the liquid (tip immersed).

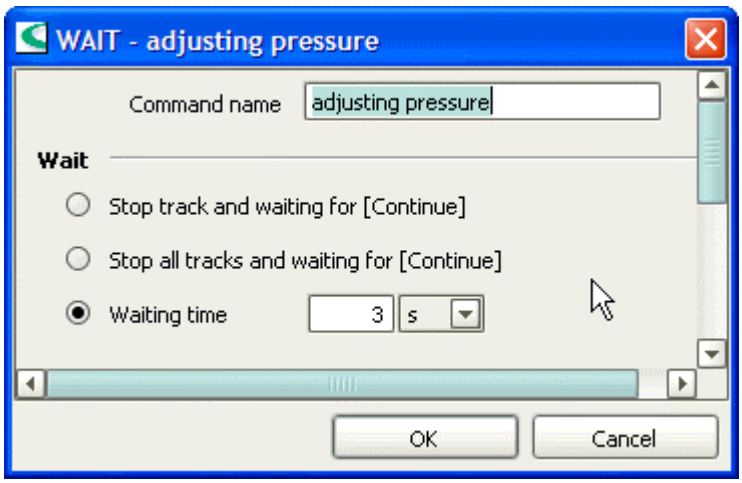


Eject sample



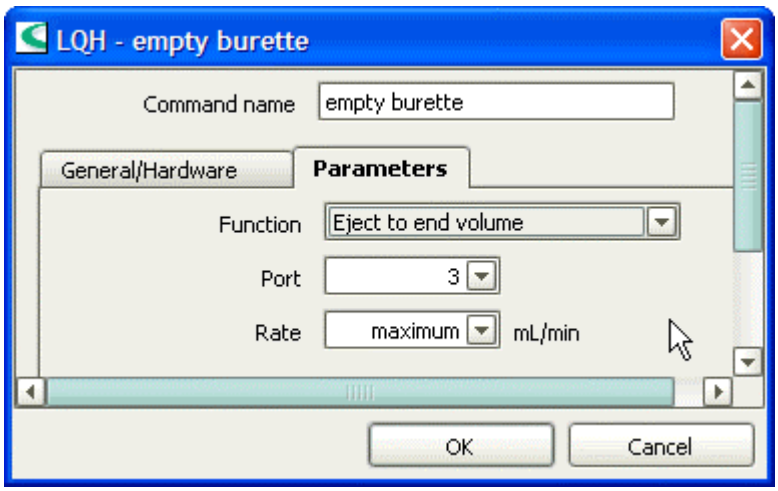


The sample should be dosed at a reduced dosing rate (<10 mL/min).



Again the system has to adjust the pressure.

Rinse



Before the next sample can be pipetted the Dosing Unit has to be prepared. For that the cylinder is emptied and a compensation command is carried out.

In order to keep sample solution carryover as low as possible, rinsing with solvent can be carried out after the sample has been ejected. This is particularly recommended for non-aqueous samples.

In preparation for the next pipetting process the cylinder should be completely ejected.

2 Calibration

2.1 Calibrating the pH glass electrode

Recommended accessory

- Comb. pH glass electrode with built-in Pt 1000 temperature sensor, e.g. 6.0257.000 Aquatrode Plus

Reagents

- Buffer solutions pH = 4.00, 7.00 and 9.00, e.g. 6.2307.100, 6.2307.110 and 6.2307.120

General

Free protons (H^+ ions) occur in solutions just as little as free electrons. They combine with water to form oxonium ions:

$$H^+ + H_2O \longrightarrow H_3O^+$$

The pH value is defined as the negative logarithm of the oxonium ion activity, i.e. of the concentration of free, dissociated oxonium ions in mol/L: $pH = -\log [H_3O^+]$

Strictly speaking, the term pH only applies to purely aqueous solutions.

The pH scale ranges from 0 to 14 with the neutral point at pH = 7.0, where the H_3O^+ and OH^- ions are present in equilibrium. pH values below 7 result from an H_3O^+ excess, pH values above 7 from an OH^- ion excess. The more acidic a solution the higher its H_3O^+ ion concentration and the lower its pH value.

Weak acids, e.g. tartaric acid, do not dissociate completely. This means that only a small fraction (approx. 2...3%) of their acid ions are released. This also means that only on very rare occasions can the pH value be used as a measure of the concentration of acids or bases.

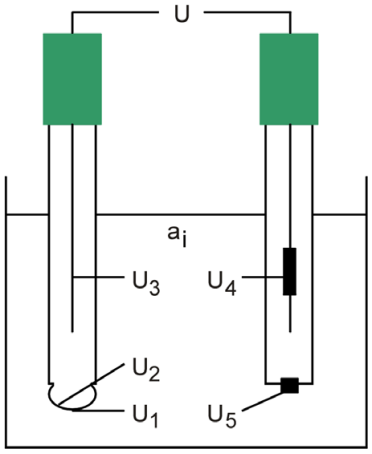
As the pH scale is logarithmic this means that small differences in pH correspond to large differences in the concentration of H_3O^+ ions. For example, at pH = 3.0 there are ten times more H_3O^+ ions present than at pH = 4.0, and at pH = 3.1 there are twice as many H_3O^+ ions present than at pH = 3.4.

The measuring setup for potentiometric measurements always consists of two electrodes – a *measuring or indicator electrode* and a *reference electrode*. For practical reasons these two electrodes are usually contained in a single *combined* electrode.

The indicator electrode (in this case the pH glass electrode) produces a potential that is dependent on the composition of the sample solution.

The reference electrode (usually Ag/AgCl) has the task of providing a potential that is as independent as possible of the sample solution (reference potential).

The potential measurement itself takes place virtually current-free by using a «voltmeter» (in this case a Titrino) with a high-impedance measuring input (this is necessary to avoid unwanted potential drops). The measured potential U is made up from the individual potentials produced by the indicator and reference electrodes. The following illustration shows a schematic diagram with a separate pH glass electrode (left) and a reference electrode (right).



U_1: Galvani potential between measuring electrode and measuring solution

U_2: Galvani potential between internal buffer and glass membrane

U_3: Galvani potential between internal reference electrode and internal buffer

U_4: Galvani potential of reference electrode

U_5: Diffusion potential at the diaphragm

The individual potentials U_2, U_3 and U_4 are determined by the construction of the electrodes and are therefore constant for a given electrode pair. The diffusion potential U_5 should be kept relatively constant and low by taking suitable measures. These measures include an optimal and clean diaphragm, constant stirrer speed during the measurements as well as a suitable reference electrolyte solution whose anions and cations have similar ionic mobilities – e.g. KCl. In this way the potential U_1 measured between the electrodes depends only on the sample solution. In the pH measurement this potential is again dependent on the activity a_i of the measuring ion (H_3O^+ ion / OH^- ion). This relationship is described by the *Nernst equation*:

$$U = U_0 + \frac{2.303 \times R \times T}{z_i \times F} \times \log a_i = U_0 + U_N \times \log a_i$$

where:

U	measured difference in potential between indicator and reference electrode
U_0	standard potential of the combined electrode (depends on its construction)
R	gas constant (8.31441 J / (K mol)
T	absolute temperature in K (273.15 + t / °C)
z_i	charge on the measuring ion i including its sign (+1 for H_3O^+ and –1 for OH^-)
a_i	activity of measuring ion
U_N	Nernst slope (59.16 mV at 25 °C and z = 1)
2.303	conversion factor from natural to common logarithm

The Nernst slope U_N describes the theoretical electrode slope and corresponds to the change in potential produced by altering a_i by a factor of ten. It depends on the temperature and charge z of the measuring ion. **Please note: The instrument compensates the effect of temperature on U_N but not on the pH value of the solution!**

The following table shows values of U_N as a function of t / °C for z = 1:

Temperature t / °C	U / mV	Temperature t / °C	U / mV
0	54.20	40	62.14
10	56.18	50	64.12
20	58.17	60	66.10
25	59.16	70	68.09
30	60.15	80	70.07
38	61.74	90	72.06

An ideal pH glass electrode has a slope of 1 (100% of the Nernst slope) and an electrode zero point pH_{as} of 7.0, the latter corresponding to U_{as} = 0 mV.

Things are different in practice. The electrode zero point should have a value for U_{as} of ±15 mV (corresponds to pH_{as} = 6.75...7.25) and the slope should be >0.95 (>56.2 mV / pH at 25 °C).

In order to «inform» the instrument of the true electrode data it is necessary to calibrate the electrode. Buffer solutions have a defined pH value which, however, is temperature-dependent. The relevant information about the buffer solution is entered during the calibration procedure. The following table shows the pH values of Metrohm buffer solutions as a function of the temperature:

Temperature t / °C	pH = 4.00 ±0.02	pH = 7.00 ±0.02	pH = 9.00 ±0.02
10	3.99	7.06	9.13
20	3.99	7.02	9.04
25	4.00	7.00	9.00
30	4.00	6.99	8.96
38	4.02	6.98	8.91
40	4.02	6.98	8.90
50	4.04	6.97	8.84
60	4.07	6.97	8.79
70	4.11	6.98	8.74
80	4.15	7.00	8.71
90	4.20	7.01	8.68

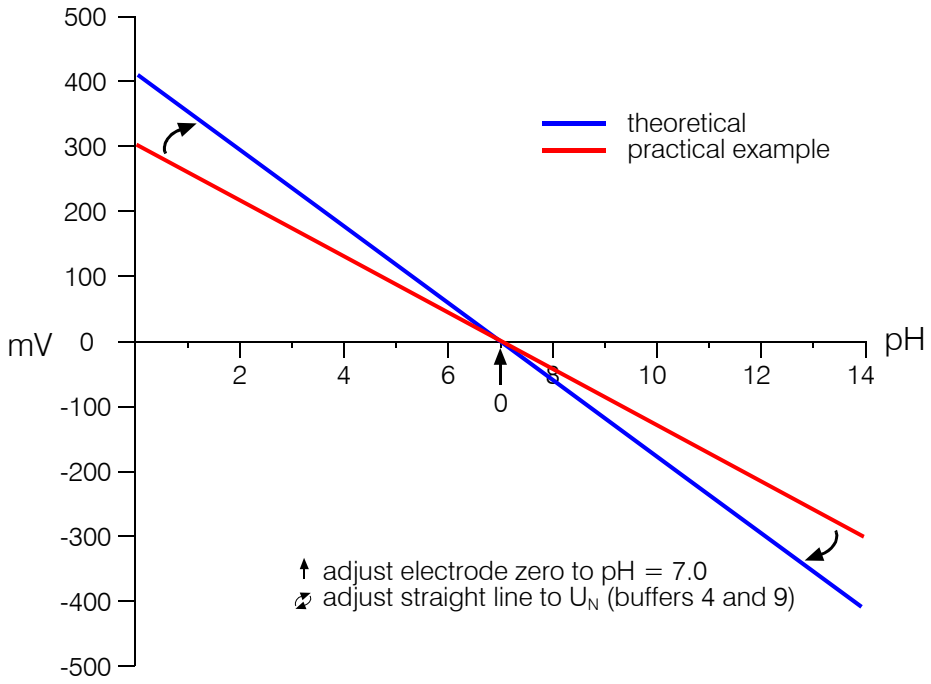
Buffer solutions are not stable!! They can be decomposed by bacteria and/or molds or – this applies to alkaline buffer solutions – alter their pH value by absorbing CO_2 from the atmosphere. This is why you should always use only fresh buffer solutions and reject them after use, i.e. not pour them back into the storage bottle.

Electrode calibration and electrode handling

We recommend the following procedure for **calibrating** a pH glass electrode:

- Remove the electrode from its storage vessel, attach a cable if necessary and connect it to the instrument.
- Open the electrolyte filling opening and, if necessary, top up the electrolyte solution.
- Rinse the electrode thoroughly with dist. H_2O and dab dry with a soft paper tissue (do not rub).
- Fill pH = 7.0 buffer solution into a beaker and add a stirrer bar.
- Immerse the electrode into the buffer solution and stir for approx. 1 min.
- On the ***tiamo*** enter the pH value of the buffer solution (at the corresponding temperature) and start the calibration with buffer 1 under stirring.
- When the measured value has been accepted, remove the electrode from the solution, rinse it thoroughly with dist. H_2O and dab dry with a soft paper tissue.
- Add pH = 4.0 or 9.0 buffer solution to a second beaker, add a stirrer bar, immerse the electrode and stir for approx. 1 min (the second buffer solution must have the same temperature as the first one).
- On the ***tiamo*** enter the pH value of the second buffer solution (at the corresponding temperature) and continue the calibration under stirring.
- After the measured value has been accepted, end the calibration. Remove the electrode from the solution, rinse the electrode thoroughly with dist. H_2O and dab dry with a soft paper tissue.

What happens in the instrument during calibration can be seen in the following plot:



Handling

Laboratory electrodes should have a long lifetime. Their characteristics (slope, response behavior, pH_{as} / U_{as}) must lie within the given criteria. In order to ensure this a few basic rules must be observed:

- After use rinse the electrode thoroughly with dist. H_2O and dab dry with a soft paper tissue. Close off the electrolyte filling opening and store the electrode by immersing it in electrolyte solution – usually c(KCl) = 3 mol/L – to an adequate depth. Dry storage leads to delayed and poor response behavior. The electrolyte solution may become concentrated and pH_{as} / U_{as} could alter. Storage in dist. H_2O could result in the diaphragm being blocked by AgCl.
- If the electrode responds sluggishly and/or the slope is unsatisfactory then the electrode membrane must be etched. This is done by immersing the membrane in a 10% solution of ammonium difluoride (NH_4HF_2, use plastic beaker) for 1 min, then swirling it for approx. 10 s in c(HCl) = 5 mol/L, rinsing it thoroughly with dist. H_2O and then wiping off the silicate residue with a moist tissue. In order to build up a new gel layer the electrode is placed in c(KCl) = 3 mol/L for 24 h (or for 5 h in the same solution at 50 °C).
- If the diaphragm becomes blocked please refer to the electrode data sheet that accompanies each electrode. Removing such a blockage is complicated and time-consuming – it is better to send the electrode to your local Metrohm distributor for this.
- Contamination by fats, oils, lacquers, paints, etc.: remove the contamination with an organic solvent (acetone, petroleum benzine, toluene), rinse thoroughly with ethanol and dist. H_2O, dab dry and place in electrolyte solution.
- Contamination by proteins: immerse the electrode in a solution of 5% pepsin in c(HCl) = 0.1 mol/L for a few hours. Then rinse thoroughly with dist. H_2O, dab dry and place in electrolyte solution.

3 Titrants

3.1 Preparing the most important alkaline and acidic titrants

General

Titrants are standard solutions, i.e. solutions that contain a defined content of a reactant. This content is given as the molar concentration *c* in mol/L. The «normality», which was frequently used previously, is no longer valid today and should therefore not be used.

Example:

- 0.1 N HCl $\Rightarrow c(HCl) = 0.1$ mol/L

Not all titrants have a stable titer, i.e. their concentration can vary with time.

Example:

- Hydroxides absorb CO_2 from the atmosphere to form carbonates

This all means that the titer of the titrant may alter as time passes. In order to know the true titer concentration the titer must be determined at regular intervals.

The so-called standard titrimetric substances are used for determining the titer. Their content hardly changes, they are available with a defined degree of purity, can be dried and can be traced back directly to standard reference materials (e.g. National Institute of Standards and Technology – NIST, USA).

Such standard titrimetric substances /secondary standards are:

- For bases potassium hydrogen phthalate, M = 204.23 g/mol
- For acids tris(hydroxymethyl)-aminomethane, M = 121.14 g/mol

Most standard solutions/titrants are commercially available as ready-to-use solutions with a titer adjusted by the manufacturer at 20 °C to 1.000. We recommend that you purchase such ready-to-use solutions and do not prepare them yourselves.

In principle titer determinations should always be carried out at the same temperature at which the analyses are later to be carried out. Please note that solutions expand as their temperature increases.

For aqueous solutions a temperature difference of 5 °C for a theoretical consumption of 10.00 mL results in a difference in volume of 12.5 µL. This means that a titer of 1.0000 at 20 °C becomes a titer of 0.9988 at 25 °C – and for non-aqueous solutions this difference is even larger. In such a case a titer of 1.0000 at 20 °C becomes a titer of 0.9950 at 25 °C (possible error 0.5%)!

Normally the titer determination is carried out three times and the mean value is used. The mean value of the titer** is saved as «TITER» in the titrant list of tiamo.

** In Europe a dimensionless factor, with at least 4 decimal places (e.g. 1.0015).
In the USA already multiplied by ***c***, with at least 4 decimal places (e.g. 1.0015 mol/L).

3.2 Titer determination of an alkaline titrant

Alkaline titrants do not have a stable titer. They may absorb CO_2 from the atmosphere to form carbonates, e.g.:

$$2\ NaOH + CO_2 = Na_2CO_3 + H_2O$$

This not only reduces the titer. The different strengths of the bases NaOH and Na_2CO_3 may negatively influence the titration curves and therefore the results – high-bias results are simulated, particularly for weak acids. In order to reduce CO_2 absorption as much as possible, soda lime (e.g. Merck no. 106839) is placed in the drying/absorber tube of the Exchange Unit.

– *c*(NaOH) = 0.1 mol/L

If possible this titrant should be bought ready for use. Otherwise dissolve 4.0 g NaOH in CO_2-free dist. H_2O, make up to 1 liter and mix.

Recommended accessories

- Comb. pH glass electrode for aqueous titrations 6.0257.000 Aquatrode Plus
- 20 mL Dosing Unit: 6.3032.220
- 10 mL Dosing Unit: 6.3032.210

Titer determination

Potassium hydrogen phthalate is dried over night in a drying oven at 105 °C and allowed to cool down in a desiccator for at least 1 h.

Approx. 2, 3 and 4 g of the dried potassium hydrogen phthalate are weighed out into three 100 mL volumetric flasks with an accuracy of 1 mg, dissolved with dist. water and filled up to the mark. The sample tubes are filled with the prepared solutions and placed on the rack. Then the determination series is started.

Calculation

TITER NaOH = 'MV.Sample size' * 'MV.Weight of PHPh' * 1000 / ('DET pH.EP {1}.VOL' * 'DET pH.CONC' * 204.2 * 100)

where:

'MV.Sample size'	Volume of the sample [mL]
'MV.Weight of PHPh'	Weight of the potassium hydrogen phthalate in the sample solution [g]
1000	Conversion factor for mL
'DET pH.EP {1}.VOL'	Volume NaOH used up to the endpoint [mL]
'DET pH.CONC'	Concentration of the used NaOH [mol/L]
204.2	Molecular weight of potassium hydrogen phthalate [g/mol]
100	Volume of the sample solution [mL]

3.3 *tiamo* method: Titer determination an alkaline titrant

Application note

With this method the titer of c(NaOH) = 0.1 mol/L can be determined. Alkaline titrants tend to absorb CO_2 from the atmosphere which results in a reduced titer value. With the titration of a primary standard the actual titer is determined. The method consists of five different tracks. In the series start track the user is asked to enter the weighed out potassium hydrogen phthalate, the rack is initialized and the system prepared for the measurements. The main track handles the addition of water, the transferring of the sample and the determination followed by the rinsing of the electrode and the titration vessel which is done after every determination.

In the exit track the results are calculated, a report is printed and the data is saved in the predefined database Robotic Transfer Analyzer (can be modified).

Finally, in the series end track, the titration vessel is filled with water in order to avoid the drying out of the electrode.

In case of an error, the error track is carried out, which means that water is given into the titration vessel.

Sample preparation

Potassium hydrogen phthalate is dried overnight in a drying oven at 105 °C and allowed to cool down in a desiccator for at least 1 h.

Approx. 2, 3 and 4 g of the dried potassium hydrogen phthalate are weighed out into three 100 mL volumetric flasks with an accuracy of 1 mg, dissolved with dist. water and filled up to the mark.

Procedure

The 11 mL sample tubes are filled with the prepared solution and placed on the rack. 3 to 6 mL of the sample solution are pipetted to the titration vessel and titrated with c(NaOH) = 0.1 mol/L.

Remarks

To run this method the 855 Robotic Titrosampler has to be adjusted. The lift positions have to be defined according to the rack and sample vessels used. For titration and the rinsing procedure an external position has to be defined, as well as a corresponding shift and work position respectively.

The value 204.2 in the calculation formula is the molecular weight of potassium hydrogen phthalate in gram per mole. The number 1000 is a calculation factor for liter.

Result report

Robotic Acid / Base Analyzer
Titer determination

Programm version tiamo 1.1

2005-11-21 10:05:51 UTC+1

Results report

Determination

Method	Titer determination of an alkaline titrant
Method saving date	2005-10-19 08:48:05 UTC+2
Method version	1
Method state	original
Determination ID	544c53b3:1070767168f:-7eca
Determination start	2005-10-19 09:47:55 UTC+2
Determination state	original
Determination version	1
Run number	14
User (full name)	Metrohm

Sample data

Sample Identification 1	Titer determination
Weight of PHPh in 100 mL	4.084 g
Sample size	4 mL

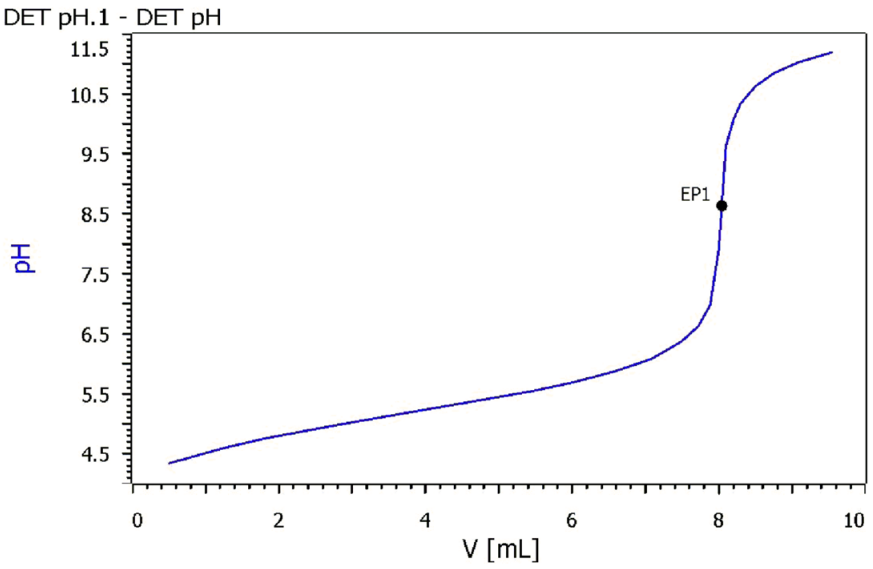
End points

DET pH **DET pH.1**

EP1	8.630	pH	8.0422	mL

Results

Titer NaOH	**0.9948**
Mean value titer	**0.9954**



tiamo™ titration and more

Robotic Acid / Base Analyzer
Titer determination

Programm version tiamo 1.1

2005-11-21 10:05:51 UTC+1

Statistical data (short)

Method . . . . . Titer determination of an alkaline titrant
Number of single determinations 10

Result name	n	Mean value	s +/-	s rel
Titer NaOH	10	0.9954	0.00122	0.12 %

3.4 Titer determination of an acidic titrant

– *c*(HCl) = 0.1 mol/L in H_2O

If possible this titrant should be bought ready for use. Otherwise place approx. 800 mL dist. H_2O in a 1000 mL volumetric flask, add 9.8 mL *w*(HCl) = 32%, make up to the mark with dist. H_2O or ethanol and mix.

Recommended accessories

- Comb. pH glass electrode for aqueous titrations 6.0257.000 Aquatrode Plus
- 20 mL Dosing Unit: 6.3032.220
- 10 mL Dosing Unit: 6.3032.210

Titer determination

Tris(hydroxymethyl)-aminomethane (TRIS) is stored for at least 24 h in a desiccator before use.

Approx. 1.2, 1.8 and 2.4 g TRIS are weighed out into three 100 mL volumetric flasks with an accuracy of 1 mg, dissolved in dist. H_2O and filled up to the mark. The sample tubes are filled with the prepared solutions and placed on the rack. Then the determination series is started.

Calculation

TITER HCl = 'MV.Sample size' * 'MV.Weight of TRIS' * 1000 / ('DET pH.EP {1}.VOL' * 'DET pH.CONC' * 121.14 * 100)

where:

'MV.Sample size'	Volume of the sample [mL]
'MV.Weight of TRIS'	Weight of the TRIS in the sample solution [g]
1000	Conversion factor for mL
'DET pH.EP {1}.VOL'	Volume HCl used up to the endpoint [mL]
'DET pH.CONC'	Concentration of the used HCl [mol/L]
121.14	Molecular weight of TRIS [g/mol]
100	Volume of the sample solution [mL]

3.5 *tiamo* method: Titer determination of an acidic titrant

Application note

With this method the titer of c(HCl) = 0.1 mol/L can be determined. Once the bottle of titrant is open the titer value changes. With the titration of a primary standard the actual titer is determined. The method consists of five different tracks. In the series start track the user is asked to enter the weighed out TRIS (tris(hydroxymethyl)-aminoethane), the rack is initialized and the system prepared for the measurements. The main track handles the addition of water, the transferring of the sample and the determination followed by the rinsing of the electrode and the titration vessel which is done after every determination.

In the exit track the results are calculated, a report is printed and the data is saved in the predefined database Robotic Transfer Analyzer (can be modified).

Finally, in the series end track, the titration vessel is filled with water in order to avoid the drying out of the electrode.

In case of an error, the error track is carried out, which means that water is given into the titration vessel.

Sample preparation

Tris(hydroxymethyl)-aminomethane (TRIS) is stored for at least 24 h in a desiccator before use.

Approx. 1.2, 1.8 and 2.4 g TRIS are weighed out into three 100 mL volumetric flasks with an accuracy of 1 mg, dissolved in dist. H_2O and filled up to the mark.

Procedure

The sample tubes are filled with the prepared solution and placed on the rack. 3 to 6 mL of the sample solution are transferred to the titration vessel and titrated with c(HCl) = 0.1 mol/L.

Remarks

To run this method the 855 Robotic Titrosampler has to be adjusted. The lift positions have to be defined according to the rack and beakers used. For titration and the rinsing procedure an external position has to be defined, as well as a corresponding shift and work position respectively.

The value 121.14 in the calculation formula is the molecular weight of TRIS in gram per mole. The number 1000 is a calculation factor for liter.

Result report

Robotic Acid / Base Analyzer
Titer determination

Programm version tiamo 1.1

2005-11-21 17:10:53 UTC+1

Results report

Determination

Method	Titer determination of an acidic titrant
Method saving date	2005-10-18 10:43:57 UTC+2
Method version	1
Method state	original
Determination ID	4d350777:1070246a555:-7cd4
Determination start	2005-10-18 11:50:18 UTC+2
Determination state	original
Determination version	1
Run number	31
User (full name)	Metrohm

Sample data

Sample Identification 1	Titer c(HCl) = 0.1M
Weight of TRIS in 100 mL	2.4292 g
Sample size	3 mL

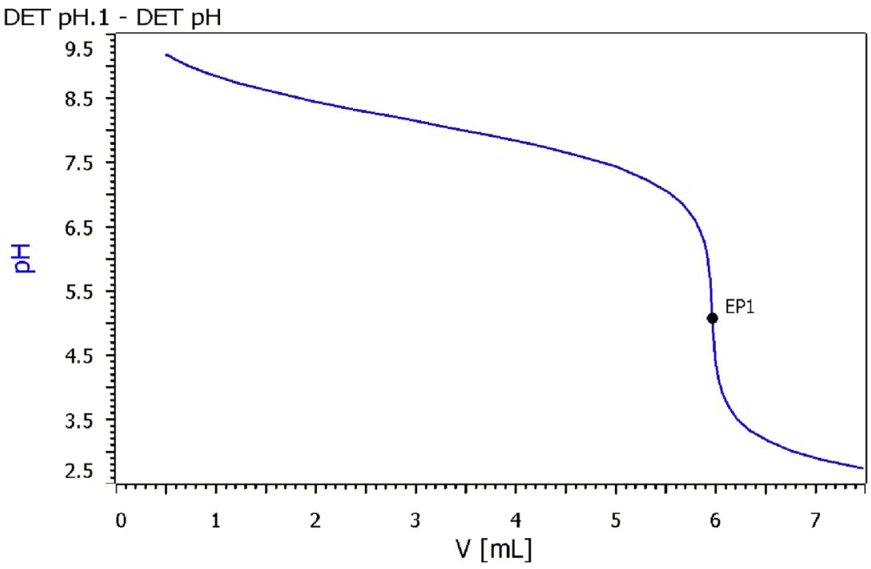
End points

DET pH **DET pH.1**

EP1	5.070	pH	5.9696	mL

Results

Titer HCl	**1.0077**
Mean value titer	**1.0065**



tiamo™ titration and more

Robotic Acid / Base Analyzer
Titer determination

Programm version tiamo 1.1

2005-11-21 17:10:53 UTC+1

Statistical data (short)

Method . . . . . Titer determination of an acidic titrant
Number of single determinations 10

Result name	n	Mean value	s +/-	s rel
Titer HCl	10	1.0065	0.00095	0.09 %

4 Typical applications for the Robotic Transfer Analyzer

4.1 Determination of c(HCl) = 0.1 mol/L

Recommended accessories

- Comb. pH glass electrode for aqueous titrations 6.0257.000 Aquatrode Plus
- 20 mL Dosing Unit: 6.3032.220
- 10 mL Dosing Unit: 6.3032.210

Reagents

- *c*(NaOH) = 0.1 mol/L
- *c*(HCl) = 0.1 mol/L
- dist. water

Analysis

The sample tubes are filled with the sample solution and placed on the rack. Then the determination series can be started.

Calculation

'DET pH.EP {1}.VOL' * 'DET pH.TITER' * 'DET pH.CONC' / 'MV.Sample size'

where:

'DET pH.EP {1}.VOL'	Volume NaOH used up to the endpoint [mL]
'DET pH.TITER'	Titer of the used NaOH [mol/L]
'DET pH.CONC'	Concentration of the used NaOH [mol/L]
'MV.Sample size'	Volume of the sample [mL]

4.2 *tiamo* method: Determination of c(HCl) = 0.1 mol/L

Application note

With this method the content of c(HCl) = 0.1 mol/L can be determined. The method consists of five different tracks. In the series start track the rack is initialized and the system prepared for the measurements. The main track handles the addition of water, the transferring of the sample and the determination followed by the rinsing of the electrode and the titration vessel which is done after every determination.

In the exit track the results are calculated, a report is printed and the data is saved in the predefined database Robotic Transfer Analyzer (can be modified).

Finally, in the series end track, the titration vessel is filled with water in order to avoid the drying out of the electrode.

In case of an error, the error track is carried out, which means that water is given into the titration vessel.

Sample preparation

No sample preparation is necessary.

Procedure

The sample tubes are filled with the sample and placed on the rack. 3 to 6 mL of the sample solution are transferred to the titration vessel and titrated with c(NaOH) = 0.1 mol/L.

Remarks

To run this method the 855 Robotic Titrosampler has to be adjusted. The lift positions have to be defined according to the rack and beakers used. For titration and the rinsing procedure an external position has to be defined, as well as a corresponding shift and work position respectively.

Result report

Robotic Transfer Analyzer
Determination of c(HCl) = 0.1 M

Programm version tiamo 1.1

2005-10-21 14:52:50 UTC+2

Results report

Determination

Method	Determination of c(HCl) = 0.1 M
Method saving date	2005-10-19 11:53:43 UTC+2
Method version	1
Method state	original
Determination ID	544c53b3:1070767168f:-7c64
Determination start	2005-10-19 13:53:24 UTC+2
Determination state	original
Determination version	1
Run number	39
User (full name)	Metrohm

Sample data

Sample Identification 1	Hydrochloric acid
Sample size	7 mL

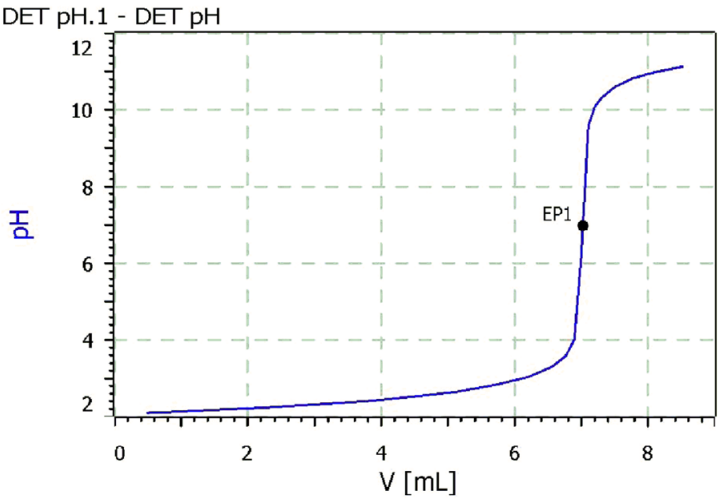
End points

DET pH **DET pH.1**

EP1	6.968	pH	7.0272	mL

Results

Content **0.0999 mol/L**



Statistical results (example)

Determination of c(HCl) = 0.1M

Sample size [mL]	Content
5.000	0.0999
6.000	0.0996
7.000	0.0997
5.000	0.0999
6.000	0.0995
7.000	0.0997
5.000	0.0999
6.000	0.0995
7.000	0.0997
5.000	0.0999
Mean value	0.0997
abs. std. dev.	0.0002
rel. std. dev. %	0.16

4.3 Determination of $c(H_2SO_4)$ = 0.1 mol/L

Recommended accessories

- Comb. pH glass electrode for aqueous titrations 6.0257.000 Aquatrode Plus
- 20 mL Dosing Unit: 6.3032.220
- 10 mL Dosing Unit: 6.3032.210

Reagents

- c(NaOH) = 0.1 mol/L
- $c(H_2SO_4)$ = 0.1 mol/L
- dist. water

Analysis

The sample tubes are filled with the sample solution and placed on the rack. Then the determination series can be started.

Calculation

'DET pH.EP {1}.VOL' * 'DET pH.TITER' * 'DET pH.CONC' / ('MV.Sample size' * 2)

where:

'DET pH.EP {1}.VOL'	Volume NaOH used up to the endpoint [mL]
'DET pH.TITER'	Titer of the used NaOH [mol/L]
'DET pH.CONC'	Concentration of the used NaOH [mol/L]
'MV.Sample size'	Volume of the sample [mL]
2	Stoichiometric factor

4.4 *tiamo* method: Determination of c(H_2SO_4) = 0.1 mol/L

Application note

With this method the content of c(H_2SO_4) = 0.1 mol/L can be determined. The method consists of five different tracks. In the series start track the rack is initialized and the system prepared for the measurements. The main track handles the addition of water, the transferring of the sample and the determination followed by the rinsing of the electrode and the titration vessel which is done after every determination.

In the exit track the results are calculated, a report is printed and the data is saved in the predefined database Robotic Transfer Analyzer (can be modified).

Finally, in the series end track, the titration vessel is filled with water in order to avoid the drying out of the electrode.

In case of an error, the error track is carried out, which means that water is given into the titration vessel.

Sample preparation

No sample preparation is necessary.

Procedure

The sample tubes are filled with the sample and placed on the rack. 3 to 6 mL of the sample solution are transferred to the titration vessel and titrated with c(NaOH) = 0.1 mol/L.

Remarks

To run this method the 855 Robotic Titrosampler has to be adjusted. The lift positions have to be defined according to the rack and beakers used. For titration and the rinsing procedure an external position has to be defined, as well as a corresponding shift and work position respectively.

The number 2 in the calculation formula is needed to factor the two protons of the sulphuric acid into the calculation.

Result report

Robotic Transfer Analyzer
Determination of c(H2SO4) = 0.1 M

Programm version tiamo 1.1

2005-10-21 14:51:51 UTC+2

Results report

Determination

Method	Determination of c(H2SO4) = 0.1 M
Method saving date	2005-10-19 11:45:18 UTC+2
Method version	1
Method state	original
Determination ID	544c53b3:1070767168f:-7d1a
Determination start	2005-10-19 12:40:10 UTC+2
Determination state	original
Determination version	1
Run number	27
User (full name)	Metrohm

Sample data

Sample Identification 1	Sulfuric acid
Sample size	6 mL

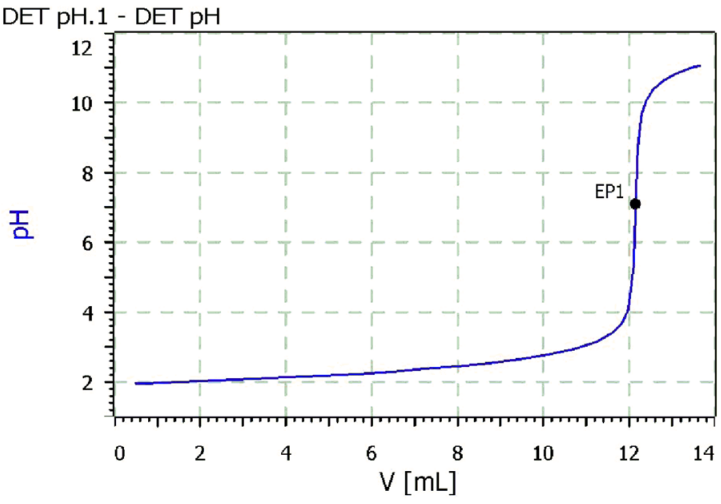
End points

DET pH **DET pH.1**

EP1	7.103	pH	12.1536	mL

Results

Content **0.1008 mol/L**



Statistical results (example)

Determination of c(H_2SO_4) = 0.1M

Sample size [mL]	Content
5.000	0.1010
6.000	0.1008
3.000	0.1010
4.000	0.1009
5.000	0.1009
6.000	0.1008
3.000	0.1010
4.000	0.1009
5.000	0.1010
6.000	0.1008
Mean value	0.1009
abs. std. dev.	0.0001
rel. std. dev. %	0.09

4.5 Determination of *c*(NaOH) = 0.1 mol/L

Recommended accessories

- Comb. pH glass electrode for aqueous titrations 6.0257.000 Aquatrode Plus
- 20 mL Dosing Unit: 6.3032.220
- 10 mL Dosing Unit: 6.3032.210

Reagents

- *c*(HCl) = 0.1 mol/L
- *c*(NaOH) = 0.1 mol/L
- dist. water

Analysis

The sample tubes are filled with the sample solution and placed on the rack. Then the determination series can be started.

Calculation

'DET pH.EP {1}.VOL' * 'DET pH.TITER' * 'DET pH.CONC' / 'MV.Sample size'

where:

'DET pH.EP {1}.VOL'	Volume HCl used up to the endpoint [mL]
'DET pH.TITER'	Titer of the used HCl [mol/L]
'DET pH.CONC'	Concentration of the used HCl [mol/L]
'MV.Sample size'	Volume of the sample [mL]

4.6 tiamo method: Determination of c(NaOH) = 0.1 mol/L

Application note

With this method the content of c(NaOH) = 0.1 mol/L can be determined. The method consists of five different tracks. In the series start track the rack is initialized and the system prepared for the measurements. The main track handles the addition of water, the transferring of the sample and the determination followed by the rinsing of the electrode and the titration vessel which is done after every determination.

In the exit track the results are calculated, a report is printed and the data is saved in the predefined database Robotic Transfer Analyzer (can be modified).

Finally, in the series end track, the titration vessel is filled with water in order to avoid the drying out of the electrode.

In case of an error, the error track is carried out, which means that water is given into the titration vessel.

Sample preparation

No sample preparation is necessary.

Procedure

The sample tubes are filled with the sample and placed on the rack. 3 to 6 mL of the sample solution are transferred to the titration vessel and titrated with c(HCl) = 0.1 mol/L.

Remarks

To run this method the 855 Robotic Titrosampler has to be adjusted. The lift positions have to be defined according to the rack and beakers used. For titration and the rinsing procedure an external position has to be defined, as well as a corresponding shift and work position respectively.

Result report

Robotic Transfer Analyzer
Determination of c(NaOH) = 0.1 M

Programm version tiamo 1.1

2005-10-21 14:34:49 UTC+2

Results report

Determination

Method	Determination of c(NaOH) = 0.1 M
Method saving date	2005-10-18 13:00:03 UTC+2
Method version	1
Method state	original
Determination ID	4d350777:1070246a555:-7b8b
Determination start	2005-10-18 13:45:51 UTC+2
Determination state	original
Determination version	1
Run number	48
User (full name)	Metrohm

Sample data

Sample Identification 1	NaOH 0.1 M
Sample size	5 mL

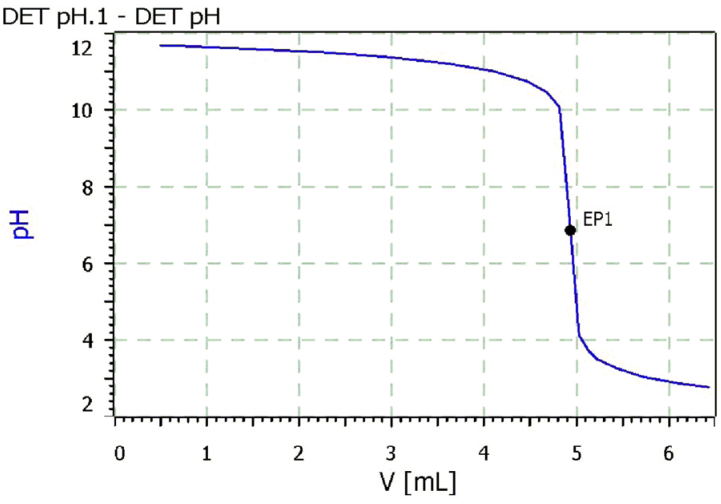
End points

DET pH **DET pH.1**

EP1	6.853	pH	4.9363	mL

Results

Content **0.0994 mol/L**



Statistical results (example)

Determination of c(NaOH) = 0.1M

Sample size [mL]	Content
5.000	0.0993
6.000	0.0993
4.000	0.0993
5.000	0.0995
6.000	0.0997
4.000	0.0993
5.000	0.0995
6.000	0.0994
4.000	0.0993
5.000	0.0994
Mean value	0.0994
abs. std. dev.	0.0001
rel. std. dev. %	0.14

4.7 Determination of $c(NH_4OH)$ = 0.1 mol/L

Recommended accessories

- Comb. pH glass electrode for aqueous titrations 6.0257.000 Aquatrode Plus
- 20 mL Dosing Unit: 6.3032.220
- 10 mL Dosing Unit: 6.3032.210

Reagents

- c(HCl) = 0.1 mol/L
- c(NaOH) = 0.1 mol/L
- dist. water

Analysis

The sample tubes are filled with the sample solution and placed on the rack. Then the determination series can be started.

Calculation

'DET pH.EP {1}.VOL' * 'DET pH.TITER' * 'DET pH.CONC' / 'MV.Sample size'

where:

'DET pH.EP {1}.VOL'	Volume HCl used up to the endpoint [mL]
'DET pH.TITER'	Titer of the used HCl [mol/L]
'DET pH.CONC'	Concentration of the used HCl [mol/L]
'MV.Sample size'	Volume of the sample [mL]

4.8 tiamo method: Determination of c(NH_4OH) = 0.1 mol/L

Application note

With this method the content of c(NH_4OH) = 0.1 mol/L can be determined. The method consists of five different tracks. In the series start track the rack is initialized and the system prepared for the measurements. The main track handles the addition of water, the transferring of the sample and the determination followed by the rinsing of the electrode and the titration vessel which is done after every determination.

In the exit track the results are calculated, a report is printed and the data is saved in the predefined database Robotic Transfer Analyzer (can be modified).

Finally, in the series end track, the titration vessel is filled with water in order to avoid the drying out of the electrode.

In case of an error, the error track is carried out, which means that water is given into the titration vessel.

Sample preparation

No sample preparation is necessary.

Procedure

The sample tubes are filled with the sample and placed on the rack. 3 to 6 mL of the sample solution are transferred to the titration vessel and titrated with c(HCl) = 0.1 mol/L.

Remarks

To run this method the 855 Robotic Titrosampler has to be adjusted. The lift positions have to be defined according to the rack and beakers used. For titration and the rinsing procedure an external position has to be defined, as well as a corresponding shift and work position respectively.

Result report

Robotic Transfer Analyzer
Determination of c(NH4OH) = 0.1 M

Programm version tiamo 1.1

2005-10-21 14:37:35 UTC+2

Results report

Determination

Method	Determination of c(NH4OH) = 0.1 M
Method saving date	2005-10-18 15:19:06 UTC+2
Method version	1
Method state	original
Determination ID	4d350777:1070246a555:-79ec
Determination start	2005-10-18 15:46:29 UTC+2
Determination state	original
Determination version	1
Run number	69
User (full name)	Metrohm

Sample data

Sample Identification 1	NH4OH 0.1 M
Sample size	5 mL

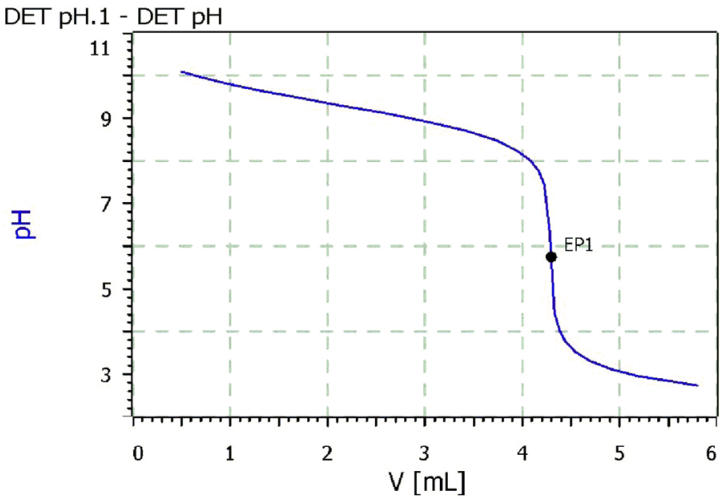
End points

DET pH **DET pH.1**

EP1	5.753	pH	4.2993	mL

Results

Content **0.0865 mol/L**



Statistical results (example)

Determination of c(NH_4OH) = 0.1M

Sample size [mL]	Content
5.000	0.0848
6.000	0.0853
4.000	0.0851
4.000	0.0853
5.000	0.0855
6.000	0.0851
4.000	0.0845
5.000	0.0847
6.000	0.0850
4.000	0.0849
Mean value	0.0850
abs. std. dev.	0.0003
rel. std. dev. %	0.37

5 Troubleshooting pH glass electrodes

5.1 Troubleshooting Aquatrode

Source of error	Effects	Cleaning	Alternatives
HF-containing solutions	Etching and dissolution of the glass membrane ➔ corrosion potential during the measurement/short working life		Use of the Sb electrode
High pH value and high alkali content	Increased alkali error ➔ pH too low		Use of electrodes with U glass
High temperatures	Rapid rise in membrane resistance by aging ➔ increased polarizability and drift		Use of electrodes with U glass. Careful treatment with etching salt and HCl
Measurements at low temperatures	High membrane resistance ➔ polarization effects		Use of electrodes with T glass and Idrolyte as reference electrolyte
Dry storage	Zero point drift	Storage in 6.2323.000 storage solution	
Non-aqueous media	Reduced sensitivity	Store in water	T glass / non-aqueous electrolyte solution
Deposition of solids on membrane surface	Slow response, zero point shift, slope reduction	Solvent or strong acids	
Deposition of proteins on membrane surface	Slow response, zero point shift, slope reduction	5% pepsin in 0.1 mol/L HCl	

5.2 Cleaning and care of pH-electrodes with fixed-sleeve diaphragm

Diaphragm type	Type of contamination	Cleaning
General	Precipitates of silver halides and silver sulfides	Immerse diaphragm for several hours in a solution of 7% thiourea in 0.1 mol/L HCl.
	Proteins, polypeptides	Immerse diaphragm for several hours in a solution of 5% pepsin in 0.1 mol/L HCl.
	Suspensions, solids, resins, glues, oils, fats	Clean electrode with suitable solvent
Fixed ground joint	All types of contamination	Aspirate off reference electrolyte and immerse electrode in the corresponding cleaning solution.
Separable ground joint	All types of contamination	Loosen the ground-joint sleeve (using hot water if necessary) and clean according to the type of contamination.

5.3 Storage

Aquatrode Plus: Store in 6.2323.000 storage solution only! The filling plug for the bridge electrolyte must not be opened.

6 Method reports

6.1 Titer determination of an alkaline titrant

tiamo™ titration and more

License ID	124049905	Program version	tiamo 1.1 - 32
Client name	TITRATION14		
User	Metrohm		2005-10-21 14:24:00 UTC+2

Method parameters

Method . . . . . Titer determination of an alkaline titrant
Method saving date . . . . . 2005-10-21 14:23:54 UTC+2
Method version 1
Method group . . . . . Robotic Transfer Analyzer
Method status . . . . . original
Method saved by (full name) . . . . . Metrohm
Method saved by (short name) . . . . . Metrohm

START **Main track**

General

Workplace view
Current view . . . . . on
Track view for live window
Live display 1 . . . . . Main track
Live display 2 . . . . . Main track
Statistics . . . . . on
Number of single determinations . . . . . not defined
Conditioning
Automatic conditioning . . . . . off

Application note

See attached documents

Method variables

Name	Type	Assignment	Value	Comment	Monitoring
Sample size	Number	Sample size		Sample size	off
Sample size unit	Text	Sample size unit		Sample size unit	off
Sample position	Number	Sample position		Sample position number	off
ID1	Text	ID1		Sample identification 1	off
Weight of PHPh	Number	ID2		Sample identification 2	off
Dillution factor	Number	ID3		Sample identification 3	off

Name . . . . . **Sample size**
Type . . . . . Number
Assignment . . . . . on . . . . . Sample size
Value . . . . . off . . . . .
Check at start . . . . . on
Comment . . . . . Sample size
Variable monitoring . . . . . off
Lower limit . . . . .
Upper limit . . . . .
Message . . . . .
Display message . . . . . on
Record message . . . . . on

Message by e-mail . . . . . off
Mail to . . . . .
Subject . . . . . Message from tiamo - Method 'New method 1' - Command 'Main track'
User . . . . .
Mail from . . . . .
SMTP Server . . . . .
POP3 Server . . . . .
Acoustic signal . . . . . off
Action . . . . . off
Stop determination . . . . . on
Stop determination and series . . . . . off

Name . . . . . **Sample position**
Type . . . . . Number
Assignment . . . . . on . . . . . Sample position
Value . . . . . off . . . . .
Check at start . . . . . on
Comment . . . . . Sample position number
Variable monitoring . . . . . off
Lower limit . . . . .
Upper limit . . . . .
Message . . . . .
Display message . . . . . on
Record message . . . . . on
Message by e-mail . . . . . off
Mail to . . . . .
Subject . . . . . Message from tiamo - Method 'New method 1' - Command 'Main track'
User . . . . .
Mail from . . . . .
SMTP Server . . . . .
POP3 Server . . . . .
Acoustic signal . . . . . off
Action . . . . . off
Stop determination . . . . . on
Stop determination and series . . . . . off

Name . . . . . **Weight of PHPh**
Type . . . . . Number
Assignment . . . . . on ID2
Value . . . . . off . . . . .
Check at start . . . . . off
Comment . . . . . Sample identification 2
Variable monitoring . . . . . off
Lower limit . . . . .
Upper limit . . . . .

Message
Display message on
Record message on
Message by e-mail off
Mail to
Subject Message from tiamo - Method 'New method 1' - Command 'Main track'
User
Mail from
SMTP Server
POP3 Server
Acoustic signal off
Action off
Stop determination on
Stop determination and series off

Name **Dillution factor**
Type Number
Assignment on ID3
Value off
Check at start off
Comment Sample identification 3
Variable monitoring off
Lower limit
Upper limit
Message
Display message on
Record message on
Message by e-mail off
Mail to
Subject Message from tiamo - Method 'New method 1' - Command 'Main track'
User
Mail from
SMTP Server
POP3 Server
Acoustic signal off
Action off
Stop determination on
Stop determination and series off

Name **Sample size unit**
Type Text
Assignment on Sample size unit
Value off
Check at start on

Comment . . . . . Sample size unit

Name **ID1**
Type . . . . . Text
Assignment . . . . . on ID1
Value . . . . . off . . . . .
Check at start . . . . . off
Comment . . . . . Sample identification 1

PUMP **add water**
Device
Device name . . . . . 855_1
Pumps
Tower 1
Pump(s) 1
Action
Switch on . . . . . off
Switch off . . . . . off
Duration . . . . . on
Time . . . . . 20 s

SEQUENCE **sample transfer**

LQH **compensate**
General/Hardware
Device
Device name . . . . . 855_1
Dosing device
Dosing device 2
Solution . . . . . Transfer
Parameters
Function . . . . . Compensate
Port 3

LQH **produce first air bubble**
General/Hardware
Device
Device name . . . . . 855_1
Dosing device
Dosing device 2
Solution . . . . . Transfer
Parameters
Function . . . . . Aspirate
Port 3
Volume . . . . . 0.1 mL
Rate . . . . . 5 mL/min

MOVE **to sample**

Device
Device name . . . . . 855_1
Target
Tower 1
Move . . . . . Sample position
Beaker test
Display message . . . . . off
Stop determination . . . . . off
Stop determination and series . . . . . on
Parameters
Shift rate . . . . . 20 °/s
Shift direction . . . . . auto
Swing rate . . . . . 55 °/s

LIFT **lift to working position**
Device
Device name . . . . . 855_1
Target
Tower 1
Lift position . . . . . Work position mm
Parameters
Lift rate . . . . . 25 mm/s

LQH **aspirate sample**
General/Hardware
Device
Device name . . . . . 855_1
Dosing device
Dosing device 2
Solution . . . . . Transfer
Parameters
Function . . . . . Aspirate
Port 3
Volume . . . . . = 'MV.Sample size' mL
Rate . . . . . 5 mL/min

WAIT **adjusting pressure**
Wait
Stop track and waiting for [Continue] . . . . . off
Stop all tracks and waiting for [Continue] . . . . . off
Waiting time . . . . . on
Time 3
Unit . . . . . s
Message
Record message . . . . . off
Message by e-mail . . . . . off
Acoustic signal . . . . . off

tiamo™ titration and more

License ID	124049905	Program version	tiamo 1.1 - 32
Client name	TITRATION14		
User	Metrohm	2005-10-21	14:24:00 UTC+2

LIFT **lift to shifting position**

Device
- Device name . . . . . 855_1

Target
- Tower 1
- Lift position . . . . . Shift position mm

Parameters
- Lift rate . . . . . 25 mm/s

LQH **produce second air bubble**

General/Hardware
- Device
  - Device name . . . . . 855_1
- Dosing device
  - Dosing device 2
  - Solution . . . . . Transfer

Parameters
- Function . . . . . Aspirate
- Port 3
- Volume . . . . . 0.1 mL
- Rate . . . . . 5 mL/min

LQH **change port**

General/Hardware
- Device
  - Device name . . . . . 855_1
- Dosing device
  - Dosing device 2
  - Solution . . . . . Transfer

Parameters
- Function . . . . . Change port
- Port 2

SWING **move to external position**

Device
- Device name . . . . . 855_1

Target
- Tower 1
- Swing . . . . . External position
- Number 1

Parameters
- Swing rate . . . . . 55 °/s

LIFT **go down to work position**

Device
- Device name . . . . . 855_1

Target
- Tower 1

Lift position . . . . . Work position mm
Parameters
Lift rate . . . . . 25 mm/s

LQH **compensation**
General/Hardware
Device
Device name . . . . . 855_1
Dosing device
Dosing device 2
Solution . . . . . Transfer
Parameters
Function . . . . . Compensate
Port 3

LQH **dose sample**
General/Hardware
Device
Device name . . . . . 855_1
Dosing device
Dosing device 2
Solution . . . . . Transfer
Parameters
Function . . . . . Dosing
Port 3
Volume . . . . . ='MV.Sample size' + 2 mL
Rate . . . . . 10 mL/min

WAIT **pressure adjustment**
Wait
Stop track and waiting for [Continue] . . . . . off
Stop all tracks and waiting for [Continue] . . . . . off
Waiting time . . . . . on
Time 3
Unit . . . . . s
Message
Record message . . . . . off
Message by e-mail . . . . . off
Acoustic signal . . . . . off

LIFT **to shifting position**
Device
Device name . . . . . 855_1
Target
Tower 1
Lift position . . . . . Shift position mm
Parameters
Lift rate . . . . . 25 mm/s

tiamo™ titration and more

License ID	124049905	Program version	tiamo 1.1 - 32
Client name	TITRATION14		
User	Metrohm	2005-10-21	14:24:00 UTC+2

DET pH **DET pH**

General/Hardware

Device

Device name . . . . . 855_1

Dosing device

Dosing device 1

Solution . . . . . NaOH

Sensor

Measuring input 1

Sensor . . . . . Aquatrode Plus

Temperature measurement . . . . . automatic

Stirrer

Stirrer 1

Stirring rate 8

Switch off automatically . . . . . on

Start conditions

Initial measured value

Signal drift . . . . . off mV/min

Min. waiting time . . . . . 0 s

Max. waiting time . . . . . 1 s

Start volume

Start volume . . . . . 0.5 mL

Dosing rate . . . . . maximum mL/min

Start measured value

Start measured value pH . . . . . off

Dosing rate . . . . . 5 mL/min

Start slope

Start slope . . . . . off pH/mL

Dosing rate . . . . . 5 mL/min

Pause

Pause . . . . . 5 s

Titration parameters

Titration rate

Titration rate . . . . . user

Measured value acceptance

Signal drift . . . . . 50.0 mV/min

Min. waiting time . . . . . 0 s

Max. waiting time . . . . . 26 s

Dosing of increments

Measuring point density 4

Min. increment . . . . . 100 µL

Max. increment . . . . . off µL

Dosing rate . . . . . maximum mL/min

Temperature

Temperature . . . . . 25.0 °C

Stop conditions

Stop volume . . . . . 20 mL
Stop measured value pH . . . . . off
Stop EP 1
Volume after EP . . . . . 1.5 mL
Stop time . . . . . off s
Filling rate . . . . . maximum mL/min

Potentiometric evaluation

Evaluation without window . . . . . on
EP criterion 5
EP recognition . . . . . all
Evaluation with measured value window (pH) . . . . . off
Evaluation with volume window (mL) . . . . . off

Additional evaluations

Fix end point evaluation . . . . . off
pK/HNP evaluation . . . . . off
Minimum evaluation . . . . . off
Maximum evaluation . . . . . off
Break point evaluation . . . . . off

Additional measured values

Additional calculated measured values . . . . . off
Additional external measured values . . . . . off

SEQUENCE clean vessel

LIFT down to working position

Device
Device name . . . . . 855_1
Target
Tower 1
Lift position . . . . . Work position mm
Parameters
Lift rate . . . . . 25 mm/s

LQH empty burette

General/Hardware

Device
Device name . . . . . 855_1
Dosing device
Dosing device 2
Solution . . . . . Transfer

Parameters

Function . . . . . Eject to end volume
Port 3
Rate . . . . . maximum mL/min

PUMP aspirate sample solution

Device
Device name . . . . . 855_1

tiamo™ titration and more

License ID 124049905 Program version tiamo 1.1 - 32
Client name TITRATION14
User Metrohm 2005-10-21 14:24:00 UTC+2

Pumps
Tower 1
Pump(s) 2
Action
Switch on . . . . . off
Switch off . . . . . off
Duration . . . . . on
Time . . . . . 10.0 s

PUMP **rinse and aspirate**
Device
Device name . . . . . 855_1
Pumps
Tower 1
Pump(s) . . . . . 1+2
Action
Switch on . . . . . off
Switch off . . . . . off
Duration . . . . . on
Time . . . . . 7 s

PUMP **empty beaker**
Device
Device name . . . . . 855_1
Pumps
Tower 1
Pump(s) 2
Action
Switch on . . . . . off
Switch off . . . . . off
Duration . . . . . on
Time . . . . . 3 s

LIFT **go to shift position**
Device
Device name . . . . . 855_1
Target
Tower 1
Lift position . . . . . Shift position mm
Parameters
Lift rate . . . . . 25 mm/s

EXIT **Exit track**

CALC **calculation**

Result name	Formula	Unit	Decimal places	Assignment	Statistics
Titer NaOH	= 'MV.Sample size' * 'MV.Weight of PHPh' * 1000 / ('DET pH.EP{1}.VOL' * 'DET pH.		4	RS01	on

Result name	Formula	Unit	Decimal places	Assignment	Statistics
Mean value titer	= 'RS.Titer NaOH.MNV'		4	RS02	off

Result name . . . . . **Titer NaOH**
Formula . . . . . = 'MV.Sample size' * 'MV.Weight of PHPh' * 1000 / ('DET pH.EP{1}.VOL' * 'DET pH.CONC' * 204.2 * 'MV.Dillution factor')
Unit . . . . .
Decimal places 4
Assignment RS01
Statistics . . . . . on
Description . . . . . RS.'Result name'[.VAL]Result value.
Result monitoring . . . . . off
Save result as common variable . . . . . off
Name . . . . .
Save result as titer . . . . . off
Solution name . . . . .

Result name . . . . . **Mean value titer**
Formula . . . . . = 'RS.Titer NaOH.MNV'
Unit . . . . .
Decimal places 4
Assignment RS02
Statistics . . . . . off
Description . . . . . RS.'Result name'[.VAL]Result value.
Result monitoring . . . . . off
Save result as common variable . . . . . off
Name . . . . .
Save result as titer . . . . . on
Solution name . . . . . NaOH

REPORT **report**

Report template
Report template . . . . . titer determination
Report output
Printer . . . . . off
PDF file . . . . . on
PDF file . . . . . C:\Dokumente und Einstellungen\demo\Eigene Dateien\mma\855 Robotic Titrosampler tiamo 1.1\Robotic Transfer Analyzer\Reports\Titer NaOH 0.1 M.pdf
Send e-mail . . . . . off

DATABASE **database**

tiamo™ titration and more

License ID 124049905 Program version tiamo 1.1 - 32
Client name TITRATION14
User Metrohm 2005-10-21 14:24:00 UTC+2

Result name	Formula	Unit	Decimal places	Assignment	Statistics
Mean value titer	= 'RS.Titer NaOH.MNV'		4	RS02	off

Result name . . . . . **Titer NaOH**
Formula . . . . . = 'MV.Sample size' * 'MV.Weight of PHPh' * 1000 / ('DET pH.EP{1}.VOL' * 'DET pH.CONC' * 204.2 * 'MV.Dillution factor')
Unit . . . . .
Decimal places 4
Assignment RS01
Statistics . . . . . on
Description . . . . . RS.'Result name'[.VAL]Result value.
Result monitoring . . . . . off
Save result as common variable . . . . . off
Name . . . . .
Save result as titer . . . . . off
Solution name . . . . .

Result name . . . . . **Mean value titer**
Formula . . . . . = 'RS.Titer NaOH.MNV'
Unit . . . . .
Decimal places 4
Assignment RS02
Statistics . . . . . off
Description . . . . . RS.'Result name'[.VAL]Result value.
Result monitoring . . . . . off
Save result as common variable . . . . . off
Name . . . . .
Save result as titer . . . . . on
Solution name . . . . . NaOH

REPORT **report**

Report template
Report template . . . . . titer determination
Report output
Printer . . . . . off
PDF file . . . . . on
PDF file . . . . . C:\Dokumente und Einstellungen\demo\Eigene Dateien\mma\855 Robotic Titrosampler tiamo 1.1\Robotic Transfer Analyzer\Reports\Titer NaOH 0.1 M.pdf
Send e-mail . . . . . off

DATABASE **database**

Database

Robotic Transfer Analyzer

SERIES START **Series start track**

REQUEST **sample size**

Sample data request

- Sample position . . . off
- ID1 . . . off
- ID2 . . . on
- ID3 . . . on
- ID4 . . . off
- ID5 . . . off
- ID6 . . . off
- ID7 . . . off
- ID8 . . . off
- Sample size . . . off
- Unit . . . off

Message . . . on

Enter the value of the weighed in potassium hydrogen phthalate and the dilution factor.

RACK **initialize rack**

Device

- Device name . . . 855_1

Rack test . . . off

SEQUENCE **prepare vessel and dosino**

SWING **swing to titration vessel**

Device

- Device name . . . 855_1

Target

- Tower . . . 1
- Swing . . . External position
- Number . . . 1

Parameters

- Swing rate . . . 55 °/s

PUMP **empty titration vessel**

Device

- Device name . . . 855_1

Pumps

- Tower . . . 1
- Pump(s) . . . 2

Action

- Switch on . . . off
- Switch off . . . off

tiamo™ titration and more

License ID	124049905	Program version	tiamo 1.1 - 32
Client name	TITRATION14		
User	Metrohm	2005-10-21	14:24:00 UTC+2

Duration . . . . . on
Time . . . . . 10 s

LIFT **lift to work position**

Device
Device name . . . . . 855_1
Target
Tower 1
Lift position . . . . . Work position mm
Parameters
Lift rate . . . . . 25 mm/s

PREP **prepare dosino**

Device
Device name . . . . . 855_1
Dosing device
Dosing device 2
Solution . . . . . Transfer

LQH **eject to end volume**

General/Hardware
Device
Device name . . . . . 855_1
Dosing device
Dosing device 2
Solution . . . . . Transfer
Parameters
Function . . . . . Eject to end volume
Port 3
Rate . . . . . maximum mL/min

PUMP **clean titration vessel**

Device
Device name . . . . . 855_1
Pumps
Tower 1
Pump(s) . . . . . 1+2
Action
Switch on . . . . . off
Switch off . . . . . off
Duration . . . . . on
Time . . . . . 10 s

PUMP **aspirate solution**

Device
Device name . . . . . 855_1
Pumps
Tower 1
Pump(s) 2

Action
Switch on . . . . . off
Switch off . . . . . off
Duration . . . . . on
Time . . . . . 3 s

LIFT **lift to shift position**
Device
Device name . . . . . 855_1
Target
Tower 1
Lift position . . . . . Shift position mm
Parameters
Lift rate . . . . . 25 mm/s

SERIES END **Series end track**

PUMP **fill vessel**
Device
Device name . . . . . 855_1
Pumps
Tower 1
Pump(s) 1
Action
Switch on . . . . . off
Switch off . . . . . off
Duration . . . . . on
Time . . . . . 20 s

ERROR **Error track**

PUMP **empty vessel**
Device
Device name . . . . . 855_1
Pumps
Tower 1
Pump(s) 2
Action
Switch on . . . . . off
Switch off . . . . . off
Duration . . . . . on
Time . . . . . 10.0 s

PUMP **add water to vessel**
Device
Device name . . . . . 855_1
Pumps
Tower 1
Pump(s) 1

Action

Switch on . . . . . off
Switch off . . . . . off
Duration . . . . . on
Time . . . . . 20 s

6.2 Titer determination of an acidic titrant

tiamo™ titration and more

License ID	124049905	Program version	tiamo 1.1 - 32
Client name	TITRATION14		
User	Metrohm		2005-10-21 14:42:57 UTC+2

Method parameters

Method . . . . . Titer determination of an acidic titrant
Method saving date . . . . . 2005-10-21 14:42:16 UTC+2
Method version 1
Method group . . . . . Robotic Transfer Analyzer
Method status . . . . . original
Method saved by (full name) . . . . . Metrohm
Method saved by (short name) . . . . . Metrohm

START **Main track**

General

Workplace view
Current view . . . . . on
Track view for live window
Live display 1 . . . . . Main track
Live display 2 . . . . . Main track
Statistics . . . . . on
Number of single determinations . . . . . not defined
Conditioning
Automatic conditioning . . . . . off

Application note

See attached documents

Method variables

Name	Type	Assignment	Value	Comment	Monitoring
Sample size	Number	Sample size		Sample size	off
Sample size unit	Text	Sample size unit		Sample size unit	off
Sample position	Number	Sample position		Sample position number	off
ID1	Text	ID1		Sample identification 1	off
Weight of TRIS	Number	ID2		Sample identification 2	off
Dillution factor	Number	ID3		Sample identification 3	off

Name . . . . . **Sample size**
Type . . . . . Number
Assignment . . . . . on . . . . . Sample size
Value . . . . . off . . . . .
Check at start . . . . . on
Comment . . . . . Sample size
Variable monitoring . . . . . off
Lower limit . . . . .
Upper limit . . . . .
Message . . . . .
Display message . . . . . on
Record message . . . . . on

Message by e-mail	off
Mail to	
Subject	Message from tiamo - Method 'New method 1' - Command 'Main track'
User	
Mail from	
SMTP Server	
POP3 Server	
Acoustic signal	off
Action	off
Stop determination	on
Stop determination and series	off

Name	**Sample position**
Type	Number
Assignment	on. Sample position
Value	off.
Check at start	on
Comment	Sample position number
Variable monitoring	off
Lower limit	
Upper limit	
Message	
Display message	on
Record message	on
Message by e-mail	off
Mail to	
Subject	Message from tiamo - Method 'New method 1' - Command 'Main track'
User	
Mail from	
SMTP Server	
POP3 Server	
Acoustic signal	off
Action	off
Stop determination	on
Stop determination and series	off

Name	**Weight of TRIS**
Type	Number
Assignment	on. ID2
Value	off.
Check at start	off
Comment	Sample identification 2
Variable monitoring	off
Lower limit	
Upper limit	

Message
Display message on
Record message on
Message by e-mail off
Mail to
Subject Message from tiamo - Method 'New method 1' - Command 'Main track'
User
Mail from
SMTP Server
POP3 Server
Acoustic signal off
Action off
Stop determination on
Stop determination and series off

Name **Dillution factor**
Type Number
Assignment on ID3
Value off
Check at start off
Comment Sample identification 3
Variable monitoring off
Lower limit
Upper limit
Message
Display message on
Record message on
Message by e-mail off
Mail to
Subject Message from tiamo - Method 'New method 1' - Command 'Main track'
User
Mail from
SMTP Server
POP3 Server
Acoustic signal off
Action off
Stop determination on
Stop determination and series off

Name **Sample size unit**
Type Text
Assignment on Sample size unit
Value off
Check at start on

	Comment	Sample size unit
	Name	**ID1**
	Type	Text
	Assignment	on ID1
	Value	off
	Check at start	off
	Comment	Sample identification 1
PUMP	**add water**	
	Device	
	Device name	855_1
	Pumps	
	Tower	1
	Pump(s)	1
	Action	
	Switch on	off
	Switch off	off
	Duration	on
	Time	20 s
SEQUENCE	**sample transfer**	
LQH	**compensate**	
	General/Hardware	
	Device	
	Device name	855_1
	Dosing device	
	Dosing device	2
	Solution	Transfer
	Parameters	
	Function	Compensate
	Port	3
LQH	**produce first air bubble**	
	General/Hardware	
	Device	
	Device name	855_1
	Dosing device	
	Dosing device	2
	Solution	Transfer
	Parameters	
	Function	Aspirate
	Port	3
	Volume	0.1 mL
	Rate	5 mL/min
MOVE	**to sample**	

Device
Device name . . . . . 855_1
Target
Tower 1
Move . . . . . Sample position
Beaker test
Display message . . . . . off
Stop determination . . . . . off
Stop determination and series . . . . . on
Parameters
Shift rate . . . . . 20 °/s
Shift direction . . . . . auto
Swing rate . . . . . 55 °/s

LIFT **lift to working position**
Device
Device name . . . . . 855_1
Target
Tower 1
Lift position . . . . . Work position mm
Parameters
Lift rate . . . . . 25 mm/s

LQH **aspirate sample**
General/Hardware
Device
Device name . . . . . 855_1
Dosing device
Dosing device 2
Solution . . . . . Transfer
Parameters
Function . . . . . Aspirate
Port 3
Volume . . . . . = 'MV.Sample size' mL
Rate . . . . . 5 mL/min

WAIT **adjusting pressure**
Wait
Stop track and waiting for [Continue] . . . . . off
Stop all tracks and waiting for [Continue] . . . . . off
Waiting time . . . . . on
Time 3
Unit . . . . . s
Message
Record message . . . . . off
Message by e-mail . . . . . off
Acoustic signal . . . . . off

tiamo™ titration and more

License ID	124049905	Program version	tiamo 1.1 - 32
Client name	TITRATION14		
User	Metrohm	2005-10-21	14:42:57 UTC+2

LIFT **lift to shifting position**

Device
- Device name . . . . . 855_1

Target
- Tower 1
- Lift position . . . . . Shift position mm

Parameters
- Lift rate . . . . . 25 mm/s

LQH **produce second air bubble**

General/Hardware
- Device
  - Device name . . . . . 855_1
- Dosing device
  - Dosing device 2
  - Solution . . . . . Transfer

Parameters
- Function . . . . . Aspirate
- Port 3
- Volume . . . . . 0.1 mL
- Rate . . . . . 5 mL/min

LQH **change port**

General/Hardware
- Device
  - Device name . . . . . 855_1
- Dosing device
  - Dosing device 2
  - Solution . . . . . Transfer

Parameters
- Function . . . . . Change port
- Port 2

SWING **move to external position**

Device
- Device name . . . . . 855_1

Target
- Tower 1
- Swing . . . . . External position
- Number 1

Parameters
- Swing rate . . . . . 55 °/s

LIFT **go down to work position**

Device
- Device name . . . . . 855_1

Target
- Tower 1

Lift position . . . . . Work position mm
Parameters
Lift rate . . . . . 25 mm/s

LQH **compensation**
General/Hardware
Device
Device name . . . . . 855_1
Dosing device
Dosing device 2
Solution . . . . . Transfer
Parameters
Function . . . . . Compensate
Port 3

LQH **dose sample**
General/Hardware
Device
Device name . . . . . 855_1
Dosing device
Dosing device 2
Solution . . . . . Transfer
Parameters
Function . . . . . Dosing
Port 3
Volume . . . . . 8 mL
Rate . . . . . 10 mL/min

WAIT **pressure adjustment**
Wait
Stop track and waiting for [Continue] . . . . . off
Stop all tracks and waiting for [Continue] . . . . . off
Waiting time . . . . . on
Time 3
Unit . . . . . s
Message
Record message . . . . . off
Message by e-mail . . . . . off
Acoustic signal . . . . . off

LIFT **to shifting position**
Device
Device name . . . . . 855_1
Target
Tower 1
Lift position . . . . . Shift position mm
Parameters
Lift rate . . . . . 25 mm/s

tiamo™ titration and more

License ID	124049905	Program version	tiamo 1.1 - 32
Client name	TITRATION14		
User	Metrohm	2005-10-21	14:42:57 UTC+2

DET pH **DET pH**

General/Hardware

Device

Device name . . . . . 855_1

Dosing device

Dosing device 1

Solution . . . . . HCl

Sensor

Measuring input 1

Sensor . . . . . Aquatrode Plus

Temperature measurement . . . . . automatic

Stirrer

Stirrer 1

Stirring rate 8

Switch off automatically . . . . . on

Start conditions

Initial measured value

Signal drift . . . . . off mV/min

Min. waiting time . . . . . 0 s

Max. waiting time . . . . . 1 s

Start volume

Start volume . . . . . 0.5 mL

Dosing rate . . . . . maximum mL/min

Start measured value

Start measured value pH . . . . . off

Dosing rate . . . . . 5 mL/min

Start slope

Start slope . . . . . off pH/mL

Dosing rate . . . . . 5 mL/min

Pause

Pause . . . . . 5 s

Titration parameters

Titration rate

Titration rate . . . . . user

Measured value acceptance

Signal drift . . . . . 50.0 mV/min

Min. waiting time . . . . . 0 s

Max. waiting time . . . . . 26 s

Dosing of increments

Measuring point density 4

Min. increment . . . . . 10.0 µL

Max. increment . . . . . off µL

Dosing rate . . . . . maximum mL/min

Temperature

Temperature . . . . . 25.0 °C

Stop conditions

Stop volume . . . . . 20 mL
Stop measured value pH . . . . . off
Stop EP 1
Volume after EP . . . . . 1.5 mL
Stop time . . . . . off s
Filling rate . . . . . maximum mL/min

Potentiometric evaluation

Evaluation without window . . . . . on
EP criterion 5
EP recognition . . . . . all
Evaluation with measured value window (pH) . . . . . off
Evaluation with volume window (mL) . . . . . off

Additional evaluations

Fix end point evaluation . . . . . off
pK/HNP evaluation . . . . . off
Minimum evaluation . . . . . off
Maximum evaluation . . . . . off
Break point evaluation . . . . . off

Additional measured values

Additional calculated measured values . . . . . off
Additional external measured values . . . . . off

SEQUENCE **clean vessel**

LIFT **down to working position**

Device
Device name . . . . . 855_1
Target
Tower 1
Lift position . . . . . Work position mm
Parameters
Lift rate . . . . . 25 mm/s

LQH **empty burette**

General/Hardware

Device
Device name . . . . . 855_1
Dosing device
Dosing device 2
Solution . . . . . Transfer

Parameters

Function . . . . . Eject to end volume
Port 3
Rate . . . . . maximum mL/min

PUMP **aspirate sample solution**

Device
Device name . . . . . 855_1

tiamo™ titration and more

License ID 124049905 Program version tiamo 1.1 - 32
Client name TITRATION14
User Metrohm 2005-10-21 14:42:57 UTC+2

Pumps
Tower 1
Pump(s) 2
Action
Switch on . . . . . off
Switch off . . . . . off
Duration . . . . . on
Time . . . . . 10.0 s

PUMP **rinse and aspirate**
Device
Device name . . . . . 855_1
Pumps
Tower 1
Pump(s) . . . . . 1+2
Action
Switch on . . . . . off
Switch off . . . . . off
Duration . . . . . on
Time . . . . . 7 s

PUMP **empty beaker**
Device
Device name . . . . . 855_1
Pumps
Tower 1
Pump(s) 2
Action
Switch on . . . . . off
Switch off . . . . . off
Duration . . . . . on
Time . . . . . 3 s

LIFT **go to shift position**
Device
Device name . . . . . 855_1
Target
Tower 1
Lift position . . . . . Shift position mm
Parameters
Lift rate . . . . . 25 mm/s

EXIT **Exit track**

CALC **calculation**

Result name	Formula	Unit	Decimal places	Assignment	Statistics
Titer HCl	='MV.Sample size' * 'MV.Weight of TRIS' * 1000 / ('DET pH.EP{1}.VOL' * 'DET pH.		4	RS01	on

Result name	Formula	Unit	Decimal places	Assignment	Statistics
Mean value titer	= 'RS.Titer HCl.MNV'		4	RS02	off

Result name . . . . . **Titer HCl**
Formula . . . . . ='MV.Sample size' * 'MV.Weight of TRIS' * 1000 / ('DET pH.EP{1}.VOL' * 'DET pH.CONC' * 121.14 * 'MV.Dillution factor')
Unit . . . . .
Decimal places 4
Assignment RS01
Statistics . . . . . on
Description . . . . . RS.'Result name'[.VAL]Result value.
Result monitoring . . . . . off
Save result as common variable . . . . . off
Name . . . . .
Save result as titer . . . . . off
Solution name . . . . .

Result name . . . . . **Mean value titer**
Formula . . . . . = 'RS.Titer HCl.MNV'
Unit . . . . .
Decimal places 4
Assignment RS02
Statistics . . . . . off
Description . . . . . RS.'Result name'[.VAL]Result value.
Result monitoring . . . . . off
Save result as common variable . . . . . off
Name . . . . .
Save result as titer . . . . . on
Solution name . . . . . HCl

REPORT **report**

Report template
Report template . . . . . titer determination
Report output
Printer . . . . . off
PDF file . . . . . on
PDF file . . . . . C:\Dokumente und Einstellungen\demo\Eigene Dateien\mma\855 Robotic Titrosampler tiamo 1.1\Robotic Transfer Analyzer\Reports\Titer HCl 0.1 M.pdf
Send e-mail . . . . . off

DATABASE **database**

Database

Robotic Transfer Analyzer

SERIES START **Series start track**

REQUEST **sample size**

Sample data request

- Sample position . . . . . off
- ID1 . . . . . off
- ID2 . . . . . on
- ID3 . . . . . on
- ID4 . . . . . off
- ID5 . . . . . off
- ID6 . . . . . off
- ID7 . . . . . off
- ID8 . . . . . off
- Sample size . . . . . off
- Unit . . . . . off

Message . . . . . on

Enter the value of the weighed in TRIS and the dillution factor.

RACK **initialize rack**

Device

- Device name . . . . . 855_1

Rack test . . . . . off

SEQUENCE **prepare vessel and dosino**

SWING **swing to titration vessel**

Device

- Device name . . . . . 855_1

Target

- Tower 1
- Swing . . . . . External position
- Number 1

Parameters

- Swing rate . . . . . 55 °/s

PUMP **empty titration vessel**

Device

- Device name . . . . . 855_1

Pumps

- Tower 1
- Pump(s) 2

Action

- Switch on . . . . . off
- Switch off . . . . . off

tiamo™ titration and more

License ID 124049905 Program version tiamo 1.1 - 32
Client name TITRATION14
User Metrohm 2005-10-21 14:42:57 UTC+2

Duration . . . . . on
Time . . . . . 10 s

LIFT **lift to work position**

Device
Device name . . . . . 855_1
Target
Tower 1
Lift position . . . . . Work position mm
Parameters
Lift rate . . . . . 25 mm/s

PREP **prepare dosino**

Device
Device name . . . . . 855_1
Dosing device
Dosing device 2
Solution . . . . . Transfer

LQH **eject to end volume**

General/Hardware
Device
Device name . . . . . 855_1
Dosing device
Dosing device 2
Solution . . . . . Transfer
Parameters
Function . . . . . Eject to end volume
Port 3
Rate . . . . . maximum mL/min

PUMP **clean titration vessel**

Device
Device name . . . . . 855_1
Pumps
Tower 1
Pump(s) . . . . . 1+2
Action
Switch on . . . . . off
Switch off . . . . . off
Duration . . . . . on
Time . . . . . 10 s

PUMP **aspirate solution**

Device
Device name . . . . . 855_1
Pumps
Tower 1
Pump(s) 2

tiamo™ titration and more

License ID 124049905 Program version tiamo 1.1 - 32
Client name TITRATION14
User Metrohm 2005-10-21 14:42:57 UTC+2

Action
Switch on . . . . . off
Switch off . . . . . off
Duration . . . . . on
Time . . . . . 3 s

LIFT **lift to shift position**
Device
Device name . . . . . 855_1
Target
Tower 1
Lift position . . . . . Shift position mm
Parameters
Lift rate . . . . . 25 mm/s

SERIES END **Series end track**

PUMP **fill vessel**
Device
Device name . . . . . 855_1
Pumps
Tower 1
Pump(s) 1
Action
Switch on . . . . . off
Switch off . . . . . off
Duration . . . . . on
Time . . . . . 20 s

ERROR **Error track**

PUMP **empty vessel**
Device
Device name . . . . . 855_1
Pumps
Tower 1
Pump(s) 2
Action
Switch on . . . . . off
Switch off . . . . . off
Duration . . . . . on
Time . . . . . 10.0 s

PUMP **add water to vessel**
Device
Device name . . . . . 855_1
Pumps
Tower 1
Pump(s) 1

tiamo™ titration and more

License ID	124049905	Program version	tiamo 1.1 - 32
Client name	TITRATION14		
User	Metrohm	2005-10-21	14:42:57 UTC+2

Action

Switch on . . . . . off
Switch off . . . . . off
Duration . . . . . on
Time . . . . . 20 s

6.3 Determination of c(HCl) = 0.1 mol/L

tiamo™ titration and more

License ID	124049905	Program version	tiamo 1.1 - 32
Client name	TITRATION14		
User	Metrohm	2005-10-21	14:01:45 UTC+2

Method parameters

Method . . . . . Determination of c(HCl) = 0.1 M
Method saving date . . . . . 2005-10-21 14:01:40 UTC+2
Method version 1
Method group . . . . . Robotic Transfer Analyzer
Method status . . . . . original
Method saved by (full name) . . . . . Metrohm
Method saved by (short name) . . . . . Metrohm

START **Main track**

General

Workplace view

Current view . . . . . on

Track view for live window

Live display 1 . . . . . Main track

Live display 2 . . . . . Main track

Statistics . . . . . off

Conditioning

Automatic conditioning . . . . . off

Application note

See attached documents

Method variables

Name	Type	Assignment	Value	Comment	Monitoring
Sample size	Number	Sample size		Sample size	off
Sample size unit	Text	Sample size unit		Sample size unit	off
Sample position	Number	Sample position		Sample position number	off
ID1	Text	ID1		Sample identification 1	off
ID2	Text	ID2		Sample identification 2	off
ID3	Text	ID3		Sample identification 3	off

Name . . . . . **Sample size**
Type . . . . . Number
Assignment . . . . . on . . . . . Sample size
Value . . . . . off . . . . .
Check at start . . . . . on
Comment . . . . . Sample size
Variable monitoring . . . . . off
Lower limit . . . . .
Upper limit . . . . .
Message . . . . .
Display message . . . . . on
Record message . . . . . on
Message by e-mail . . . . . off
Mail to . . . . .

Subject	Message from tiamo - Method 'New method 1' - Command 'Main track'
User	
Mail from	
SMTP Server	
POP3 Server	
Acoustic signal	off
Action	off
Stop determination	on
Stop determination and series	off

Name	**Sample position**
Type	Number
Assignment	on. Sample position
Value	off.
Check at start	on
Comment	Sample position number
Variable monitoring	off
Lower limit	
Upper limit	
Message	
Display message	on
Record message	on
Message by e-mail	off
Mail to	
Subject	Message from tiamo - Method 'New method 1' - Command 'Main track'
User	
Mail from	
SMTP Server	
POP3 Server	
Acoustic signal	off
Action	off
Stop determination	on
Stop determination and series	off

Name	**Sample size unit**
Type	Text
Assignment	on. Sample size unit
Value	off.
Check at start	on
Comment	Sample size unit

Name	**ID1**
Type	Text
Assignment	on. ID1
Value	off.

Check at start . . . . . off
Comment . . . . . Sample identification 1

Name **ID2**
Type . . . . . Text
Assignment . . . . . on ID2
Value . . . . . off . . . . .
Check at start . . . . . off
Comment . . . . . Sample identification 2

Name **ID3**
Type . . . . . Text
Assignment . . . . . on ID3
Value . . . . . off . . . . .
Check at start . . . . . off
Comment . . . . . Sample identification 3

PUMP **add water**

Device
Device name . . . . . 855_1
Pumps
Tower 1
Pump(s) 1
Action
Switch on . . . . . off
Switch off . . . . . off
Duration . . . . . on
Time . . . . . 20 s

SEQUENCE **sample transfer**

LQH **compensate**

General/Hardware

Device
Device name . . . . . 855_1
Dosing device
Dosing device 2
Solution . . . . . Transfer

Parameters

Function . . . . . Compensate
Port 3

LQH **produce first air bubble**

General/Hardware

Device
Device name . . . . . 855_1
Dosing device
Dosing device 2

Solution . . . . . Transfer

Parameters

Function . . . . . Aspirate
Port 3
Volume . . . . . 0.1 mL
Rate . . . . . 5 mL/min

MOVE **to sample**

Device
Device name . . . . . 855_1
Target
Tower 1
Move . . . . . Sample position
Beaker test
Display message . . . . . off
Stop determination . . . . . off
Stop determination and series . . . . . on
Parameters
Shift rate . . . . . 20 °/s
Shift direction . . . . . auto
Swing rate . . . . . 55 °/s

LIFT **lift to working position**

Device
Device name . . . . . 855_1
Target
Tower 1
Lift position . . . . . Work position mm
Parameters
Lift rate . . . . . 25 mm/s

LQH **aspirate sample**

General/Hardware

Device
Device name . . . . . 855_1
Dosing device
Dosing device 2
Solution . . . . . Transfer

Parameters

Function . . . . . Aspirate
Port 3
Volume . . . . . = 'MV.Sample size' mL
Rate . . . . . 5 mL/min

WAIT **adjusting pressure**

Wait
Stop track and waiting for [Continue] . . . . . off
Stop all tracks and waiting for [Continue] . . . . . off

tiamo™ titration and more

License ID 124049905 Program version tiamo 1.1 - 32
Client name TITRATION14
User Metrohm 2005-10-21 14:01:45 UTC+2

Waiting time . . . on
Time . . . 3
Unit . . . s
Message
Record message . . . off
Message by e-mail . . . off
Acoustic signal . . . off

LIFT **lift to shifting position**
Device
Device name . . . 855_1
Target
Tower . . . 1
Lift position . . . Shift position mm
Parameters
Lift rate . . . 25 mm/s

LQH **produce second air bubble**
General/Hardware
Device
Device name . . . 855_1
Dosing device
Dosing device . . . 2
Solution . . . Transfer
Parameters
Function . . . Aspirate
Port . . . 3
Volume . . . 0.1 mL
Rate . . . 5 mL/min

LQH **change port**
General/Hardware
Device
Device name . . . 855_1
Dosing device
Dosing device . . . 2
Solution . . . Transfer
Parameters
Function . . . Change port
Port . . . 2

SWING **move to external position**
Device
Device name . . . 855_1
Target
Tower . . . 1
Swing . . . External position
Number . . . 1

Parameters
Swing rate . . . . . 55 °/s

LIFT **go down to work position**
Device
Device name . . . . . 855_1
Target
Tower 1
Lift position . . . . . Work position mm
Parameters
Lift rate . . . . . 25 mm/s

LQH **compensation**
General/Hardware
Device
Device name . . . . . 855_1
Dosing device
Dosing device 2
Solution . . . . . Transfer
Parameters
Function . . . . . Compensate
Port 3

LQH **dose sample**
General/Hardware
Device
Device name . . . . . 855_1
Dosing device
Dosing device 2
Solution . . . . . Transfer
Parameters
Function . . . . . Dosing
Port 3
Volume . . . . . ='MV.Sample size' + 2 mL
Rate . . . . . 10 mL/min

WAIT **pressure adjustment**
Wait
Stop track and waiting for [Continue] . . . . . off
Stop all tracks and waiting for [Continue] . . . . . off
Waiting time . . . . . on
Time 3
Unit . . . . . s
Message
Record message . . . . . off
Message by e-mail . . . . . off
Acoustic signal . . . . . off

LIFT **to shifting position**

tiamo™ titration and more

License ID	124049905	Program version	tiamo 1.1 - 32
Client name	TITRATION14		
User	Metrohm	2005-10-21	14:01:45 UTC+2

Device
- Device name . . . . . 855_1

Target
- Tower 1
- Lift position . . . . . Shift position mm

Parameters
- Lift rate . . . . . 25 mm/s

DET pH **DET pH**

General/Hardware

Device
- Device name . . . . . 855_1

Dosing device
- Dosing device 1
- Solution . . . . . NaOH

Sensor
- Measuring input 1
- Sensor . . . . . Aquatrode Plus
- Temperature measurement . . . . . automatic

Stirrer
- Stirrer 1
- Stirring rate 8
- Switch off automatically . . . . . on

Start conditions

Initial measured value
- Signal drift . . . . . off mV/min
- Min. waiting time . . . . . 0 s
- Max. waiting time . . . . . 1 s

Start volume
- Start volume . . . . . 0.5 mL
- Dosing rate . . . . . maximum mL/min

Start measured value
- Start measured value pH . . . . . off
- Dosing rate . . . . . 5 mL/min

Start slope
- Start slope . . . . . off pH/mL
- Dosing rate . . . . . 5 mL/min

Pause
- Pause . . . . . 5 s

Titration parameters

Titration rate
- Titration rate . . . . . user

Measured value acceptance
- Signal drift . . . . . 50.0 mV/min
- Min. waiting time . . . . . 0 s
- Max. waiting time . . . . . 26 s

Dosing of increments

Measuring point density 4
Min. increment . . . . . 100 µL
Max. increment . . . . . off µL
Dosing rate . . . . . maximum mL/min
Temperature
Temperature . . . . . 25.0 °C
Stop conditions
Stop volume . . . . . 20 mL
Stop measured value pH . . . . . off
Stop EP 1
Volume after EP . . . . . 1.5 mL
Stop time . . . . . off s
Filling rate . . . . . maximum mL/min
Potentiometric evaluation
Evaluation without window . . . . . on
EP criterion 5
EP recognition . . . . . all
Evaluation with measured value window (pH) . . . . . off
Evaluation with volume window (mL) . . . . . off
Additional evaluations
Fix end point evaluation . . . . . off
pK/HNP evaluation . . . . . off
Minimum evaluation . . . . . off
Maximum evaluation . . . . . off
Break point evaluation . . . . . off
Additional measured values
Additional calculated measured values . . . . . off
Additional external measured values . . . . . off

SEQUENCE **clean vessel**

LIFT **down to working position**
Device
Device name . . . . . 855_1
Target
Tower 1
Lift position . . . . . Work position mm
Parameters
Lift rate . . . . . 25 mm/s

LQH **empty burette**
General/Hardware
Device
Device name . . . . . 855_1
Dosing device
Dosing device 2
Solution . . . . . Transfer
Parameters

tiamo™ titration and more

License ID 124049905 Program version tiamo 1.1 - 32
Client name TITRATION14
User Metrohm 2005-10-21 14:01:45 UTC+2

Function . . . . . Eject to end volume
Port 3
Rate . . . . . maximum mL/min

PUMP **aspirate sample solution**

Device
Device name . . . . . 855_1
Pumps
Tower 1
Pump(s) 2
Action
Switch on . . . . . off
Switch off . . . . . off
Duration . . . . . on
Time . . . . . 10.0 s

PUMP **rinse and aspirate**

Device
Device name . . . . . 855_1
Pumps
Tower 1
Pump(s) . . . . . 1+2
Action
Switch on . . . . . off
Switch off . . . . . off
Duration . . . . . on
Time . . . . . 7 s

PUMP **empty beaker**

Device
Device name . . . . . 855_1
Pumps
Tower 1
Pump(s) 2
Action
Switch on . . . . . off
Switch off . . . . . off
Duration . . . . . on
Time . . . . . 3 s

LIFT **go to shift position**

Device
Device name . . . . . 855_1
Target
Tower 1
Lift position . . . . . Shift position mm
Parameters
Lift rate . . . . . 25 mm/s

tiamo™ titration and more

License ID 124049905 Program version tiamo 1.1 - 32
Client name TITRATION14
User Metrohm 2005-10-21 14:01:45 UTC+2

EXIT **Exit track**

CALC **calculation**

Result name	Formula	Unit	Decimal places	Assignment	Statistics
Content	= 'DET pH.EP{1}.VOL' * 'DET pH.TITER' * 'DET pH.CONC' / ('MV.Sample size')	mol/L	4	RS01	off

Result name . . . . . **Content**
Formula . . . . . = 'DET pH.EP{1}.VOL' * 'DET pH.TITER' * 'DET pH.CONC' / ('MV.Sample size')
Unit . . . . . mol/L
Decimal places 4
Assignment RS01
Statistics . . . . . off
Description . . . . . RS.'Result name'[.VAL]Result value.
Result monitoring . . . . . off
Save result as common variable . . . . . off
Name . . . . .
Save result as titer . . . . . off
Solution name . . . . .

REPORT **report**

Report template
Report template . . . . . Determination of c(HCl) = 0.1 M
Report output
Printer . . . . . off
PDF file . . . . . on
PDF file . . . . . C:\Programme\Metrohm\tiamo\Det HCl 0.1 M.pdf
Send e-mail . . . . . off

DATABASE **database**

Database
Robotic Transfer Analyzer

SERIES START **Series start track**

RACK **initialize rack**

Device
Device name . . . . . 855_1
Rack test . . . . . off

SEQUENCE **prepare vessel and dosino**

SWING **swing to titration vessel**

Device

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License ID 124049905 Program version tiamo 1.1 - 32
Client name TITRATION14
User Metrohm 2005-10-21 14:01:45 UTC+2

Device name . . . . . 855_1
Target
Tower 1
Swing . . . . . External position
Number 1
Parameters
Swing rate . . . . . 55 °/s

PUMP **empty titration vessel**
Device
Device name . . . . . 855_1
Pumps
Tower 1
Pump(s) 2
Action
Switch on . . . . . off
Switch off . . . . . off
Duration . . . . . on
Time . . . . . 10 s

LIFT **lift to work position**
Device
Device name . . . . . 855_1
Target
Tower 1
Lift position . . . . . Work position mm
Parameters
Lift rate . . . . . 25 mm/s

PREP **prepare dosino**
Device
Device name . . . . . 855_1
Dosing device
Dosing device 2
Solution . . . . . Transfer

LQH **eject to end volume**
General/Hardware
Device
Device name . . . . . 855_1
Dosing device
Dosing device 2
Solution . . . . . Transfer
Parameters
Function . . . . . Eject to end volume
Port 3
Rate . . . . . maximum mL/min

PUMP **clean titration vessel**

Device
Device name . . . . . 855_1
Pumps
Tower 1
Pump(s) . . . . . 1+2
Action
Switch on . . . . . off
Switch off . . . . . off
Duration . . . . . on
Time . . . . . 10 s

PUMP **aspirate solution**
Device
Device name . . . . . 855_1
Pumps
Tower 1
Pump(s) 2
Action
Switch on . . . . . off
Switch off . . . . . off
Duration . . . . . on
Time . . . . . 3 s

LIFT **lift to shift position**
Device
Device name . . . . . 855_1
Target
Tower 1
Lift position . . . . . Shift position mm
Parameters
Lift rate . . . . . 25 mm/s

SERIES END **Series end track**

PUMP **fill vessel**
Device
Device name . . . . . 855_1
Pumps
Tower 1
Pump(s) 1
Action
Switch on . . . . . off
Switch off . . . . . off
Duration . . . . . on
Time . . . . . 20 s

ERROR **Error track**

PUMP **empty vessel**

tiamo™ titration and more

License ID 124049905 Program version tiamo 1.1 - 32
Client name TITRATION14
User Metrohm 2005-10-21 14:01:45 UTC+2

Device
Device name . . . . . 855_1
Pumps
Tower 1
Pump(s) 2
Action
Switch on . . . . . off
Switch off . . . . . off
Duration . . . . . on
Time . . . . . 10.0 s

PUMP **add water to vessel**
Device
Device name . . . . . 855_1
Pumps
Tower 1
Pump(s) 1
Action
Switch on . . . . . off
Switch off . . . . . off
Duration . . . . . on
Time . . . . . 20 s

6.4 Determination of $c(H_2SO_4)$ = 0.1 mol/L

License ID	124049905	Program version	tiamo 1.1 - 32
Client name	TITRATION14		
User	Metrohm	2005-10-21	13:57:52 UTC+2

Method parameters

Method . . . . . Determination of c(H2SO4) = 0.1 M
Method saving date . . . . . 2005-10-21 13:57:42 UTC+2
Method version 1
Method group . . . . . Robotic Transfer Analyzer
Method status . . . . . original
Method saved by (full name) . . . . . Metrohm
Method saved by (short name) . . . . . Metrohm

START **Main track**

General

Workplace view
Current view . . . . . on
Track view for live window
Live display 1 . . . . . Main track
Live display 2 . . . . . Main track
Statistics . . . . . off
Conditioning
Automatic conditioning . . . . . off

Application note

See attached documents

Method variables

Name	Type	Assignment	Value	Comment	Monitoring
Sample size	Number	Sample size		Sample size	off
Sample size unit	Text	Sample size unit		Sample size unit	off
Sample position	Number	Sample position		Sample position number	off
ID1	Text	ID1		Sample identification 1	off
ID2	Text	ID2		Sample identification 2	off
ID3	Text	ID3		Sample identification 3	off

Name . . . . . **Sample size**
Type . . . . . Number
Assignment . . . . . on . . . . . Sample size
Value . . . . . off . . . . .
Check at start . . . . . on
Comment . . . . . Sample size
Variable monitoring . . . . . off
Lower limit . . . . .
Upper limit . . . . .
Message . . . . .
Display message . . . . . on
Record message . . . . . on
Message by e-mail . . . . . off

Mail to
Subject Message from tiamo - Method 'New method 1' - Command 'Main track'
User
Mail from
SMTP Server
POP3 Server
Acoustic signal off
Action off
Stop determination on
Stop determination and series off

Name **Sample position**
Type Number
Assignment on Sample position
Value off
Check at start on
Comment Sample position number
Variable monitoring off
Lower limit
Upper limit
Message
Display message on
Record message on
Message by e-mail off
Mail to
Subject Message from tiamo - Method 'New method 1' - Command 'Main track'
User
Mail from
SMTP Server
POP3 Server
Acoustic signal off
Action off
Stop determination on
Stop determination and series off

Name **Sample size unit**
Type Text
Assignment on Sample size unit
Value off
Check at start on
Comment Sample size unit

Name **ID1**
Type Text
Assignment on ID1

Value . . . . . off.
Check at start . . . . . off
Comment . . . . . Sample identification 1

Name **ID2**
Type . . . . . Text
Assignment . . . . . on. ID2
Value . . . . . off.
Check at start . . . . . off
Comment . . . . . Sample identification 2

Name **ID3**
Type . . . . . Text
Assignment . . . . . on. ID3
Value . . . . . off.
Check at start . . . . . off
Comment . . . . . Sample identification 3

PUMP **add water**

Device
- Device name . . . . . 855_1

Pumps
- Tower 1
- Pump(s) 1

Action
- Switch on . . . . . off
- Switch off . . . . . off
- Duration . . . . . on
- Time . . . . . 20 s

SEQUENCE **sample transfer**

LQH **compensate**

General/Hardware

Device
- Device name . . . . . 855_1

Dosing device
- Dosing device 2
- Solution . . . . . Transfer

Parameters
- Function . . . . . Compensate
- Port 3

LQH **produce first air bubble**

General/Hardware

Device
- Device name . . . . . 855_1

Dosing device

Dosing device 2
Solution . . . . . Transfer

Parameters

Function . . . . . Aspirate
Port 3
Volume . . . . . 0.1 mL
Rate . . . . . 5 mL/min

MOVE **to sample**

Device
Device name . . . . . 855_1
Target
Tower 1
Move . . . . . Sample position
Beaker test
Display message . . . . . off
Stop determination . . . . . off
Stop determination and series . . . . . on
Parameters
Shift rate . . . . . 20 °/s
Shift direction . . . . . auto
Swing rate . . . . . 55 °/s

LIFT **lift to working position**

Device
Device name . . . . . 855_1
Target
Tower 1
Lift position . . . . . Work position mm
Parameters
Lift rate . . . . . 25 mm/s

LQH **aspirate sample**

General/Hardware

Device
Device name . . . . . 855_1
Dosing device
Dosing device 2
Solution . . . . . Transfer

Parameters

Function . . . . . Aspirate
Port 3
Volume . . . . . = 'MV.Sample size' mL
Rate . . . . . 5 mL/min

WAIT **adjusting pressure**

Wait
Stop track and waiting for [Continue] . . . . . off

Stop all tracks and waiting for [Continue] . . . . . off
Waiting time . . . . . on
Time 3
Unit . . . . . s
Message
Record message . . . . . off
Message by e-mail . . . . . off
Acoustic signal . . . . . off

LIFT **lift to shifting position**
Device
Device name . . . . . 855_1
Target
Tower 1
Lift position . . . . . Shift position mm
Parameters
Lift rate . . . . . 25 mm/s

LQH **produce second air bubble**
General/Hardware
Device
Device name . . . . . 855_1
Dosing device
Dosing device 2
Solution . . . . . Transfer
Parameters
Function . . . . . Aspirate
Port 3
Volume . . . . . 0.1 mL
Rate . . . . . 5 mL/min

LQH **change port**
General/Hardware
Device
Device name . . . . . 855_1
Dosing device
Dosing device 2
Solution . . . . . Transfer
Parameters
Function . . . . . Change port
Port 2

SWING **move to external position**
Device
Device name . . . . . 855_1
Target
Tower 1
Swing . . . . . External position

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License ID 124049905 Program version tiamo 1.1 - 32
Client name TITRATION14
User Metrohm 2005-10-21 13:57:52 UTC+2

Number 1
Parameters
Swing rate . . . . . 55 °/s

LIFT **go down to work position**
Device
Device name . . . . . 855_1
Target
Tower 1
Lift position . . . . . Work position mm
Parameters
Lift rate . . . . . 25 mm/s

LQH **compensation**
General/Hardware
Device
Device name . . . . . 855_1
Dosing device
Dosing device 2
Solution . . . . . Transfer
Parameters
Function . . . . . Compensate
Port 3

LQH **dose sample**
General/Hardware
Device
Device name . . . . . 855_1
Dosing device
Dosing device 2
Solution . . . . . Transfer
Parameters
Function . . . . . Dosing
Port 3
Volume . . . . . ='MV.Sample size' + 2 mL
Rate . . . . . 10 mL/min

WAIT **pressure adjustment**
Wait
Stop track and waiting for [Continue] . . . . . off
Stop all tracks and waiting for [Continue] . . . . . off
Waiting time . . . . . on
Time 3
Unit . . . . . s
Message
Record message . . . . . off
Message by e-mail . . . . . off
Acoustic signal . . . . . off

LIFT **to shifting position**

Device
- Device name . . . . . 855_1

Target
- Tower 1
- Lift position . . . . . Shift position mm

Parameters
- Lift rate . . . . . 25 mm/s

DET pH **DET pH**

General/Hardware

Device
- Device name . . . . . 855_1

Dosing device
- Dosing device 1
- Solution . . . . . NaOH

Sensor
- Measuring input 1
- Sensor . . . . . Aquatrode Plus
- Temperature measurement . . . . . automatic

Stirrer
- Stirrer 1
- Stirring rate 8
- Switch off automatically . . . . . on

Start conditions

Initial measured value
- Signal drift . . . . . off mV/min
- Min. waiting time . . . . . 0 s
- Max. waiting time . . . . . 1 s

Start volume
- Start volume . . . . . 0.5 mL
- Dosing rate . . . . . maximum mL/min

Start measured value
- Start measured value pH . . . . . off
- Dosing rate . . . . . 5 mL/min

Start slope
- Start slope . . . . . off pH/mL
- Dosing rate . . . . . 5 mL/min

Pause
- Pause . . . . . 5 s

Titration parameters

Titration rate
- Titration rate . . . . . user

Measured value acceptance
- Signal drift . . . . . 50.0 mV/min
- Min. waiting time . . . . . 0 s

Max. waiting time . . . . . 26 s
Dosing of increments
Measuring point density 4
Min. increment . . . . . 100 µL
Max. increment . . . . . off µL
Dosing rate . . . . . maximum mL/min
Temperature
Temperature . . . . . 25.0 °C
Stop conditions
Stop volume . . . . . 20 mL
Stop measured value pH . . . . . off
Stop EP 1
Volume after EP . . . . . 1.5 mL
Stop time . . . . . off s
Filling rate . . . . . maximum mL/min
Potentiometric evaluation
Evaluation without window . . . . . on
EP criterion 5
EP recognition . . . . . all
Evaluation with measured value window (pH) . . . . . off
Evaluation with volume window (mL) . . . . . off
Additional evaluations
Fix end point evaluation . . . . . off
pK/HNP evaluation . . . . . off
Minimum evaluation . . . . . off
Maximum evaluation . . . . . off
Break point evaluation . . . . . off
Additional measured values
Additional calculated measured values . . . . . off
Additional external measured values . . . . . off

SEQUENCE **clean vessel**

LIFT **down to working position**
Device
Device name . . . . . 855_1
Target
Tower 1
Lift position . . . . . Work position mm
Parameters
Lift rate . . . . . 25 mm/s

LQH **empty burette**
General/Hardware
Device
Device name . . . . . 855_1
Dosing device
Dosing device 2

Solution . . . . . Transfer

Parameters

Function . . . . . Eject to end volume
Port 3
Rate . . . . . maximum mL/min

PUMP **aspirate sample solution**

Device
Device name . . . . . 855_1
Pumps
Tower 1
Pump(s) 2
Action
Switch on . . . . . off
Switch off . . . . . off
Duration . . . . . on
Time . . . . . 10.0 s

PUMP **rinse and aspirate**

Device
Device name . . . . . 855_1
Pumps
Tower 1
Pump(s) . . . . . 1+2
Action
Switch on . . . . . off
Switch off . . . . . off
Duration . . . . . on
Time . . . . . 7 s

PUMP **empty beaker**

Device
Device name . . . . . 855_1
Pumps
Tower 1
Pump(s) 2
Action
Switch on . . . . . off
Switch off . . . . . off
Duration . . . . . on
Time . . . . . 3 s

LIFT **go to shift position**

Device
Device name . . . . . 855_1
Target
Tower 1
Lift position . . . . . Shift position mm

tiamo™ titration and more

License ID 124049905 Program version tiamo 1.1 - 32
Client name TITRATION14
User Metrohm 2005-10-21 13:57:52 UTC+2

Parameters
Lift rate . . . . . 25 mm/s

EXIT **Exit track**

CALC **calculation**

Result name	Formula	Unit	Decimal places	Assignment	Statistics
Content	= 'DET pH.EP{1}.VOL' * 'DET pH.TITER' * 'DET pH.CONC' / ('MV.Sample size' * 2)	mol/L	4	RS01	off

Result name . . . . . **Content**
Formula . . . . . = 'DET pH.EP{1}.VOL' * 'DET pH.TITER' * 'DET pH.CONC' / ('MV.Sample size' * 2)
Unit . . . . . mol/L
Decimal places 4
Assignment RS01
Statistics . . . . . off
Description . . . . . RS.'Result name'[.VAL]Result value.
Result monitoring . . . . . off
Save result as common variable . . . . . off
Name . . . . .
Save result as titer . . . . . off
Solution name . . . . .

REPORT **report**
Report template
Report template . . . . . Determination of c(H2SO4) = 0.1 M
Report output
Printer . . . . . off
PDF file . . . . . on
PDF file . . . . . C:\Programme\Metrohm\tiamo\Det H2SO4 0.1 M.pdf
Send e-mail . . . . . off

DATABASE **database**

Database

Robotic Transfer Analyzer

SERIES START **Series start track**

RACK **initialize rack**
Device
Device name . . . . . 855_1
Rack test . . . . . off

SEQUENCE **prepare vessel and dosino**

SWING **swing to titration vessel**

Device
- Device name . . . . . 855_1

Target
- Tower 1
- Swing . . . . . External position
- Number 1

Parameters
- Swing rate . . . . . 55 °/s

PUMP **empty titration vessel**

Device
- Device name . . . . . 855_1

Pumps
- Tower 1
- Pump(s) 2

Action
- Switch on . . . . . off
- Switch off . . . . . off
- Duration . . . . . on
- Time . . . . . 10 s

LIFT **lift to work position**

Device
- Device name . . . . . 855_1

Target
- Tower 1
- Lift position . . . . . Work position mm

Parameters
- Lift rate . . . . . 25 mm/s

PREP **prepare dosino**

Device
- Device name . . . . . 855_1

Dosing device
- Dosing device 2
- Solution . . . . . Transfer

LQH **eject to end volume**

General/Hardware
- Device
  - Device name . . . . . 855_1
- Dosing device
  - Dosing device 2
  - Solution . . . . . Transfer

Parameters
- Function . . . . . Eject to end volume
- Port 3

tiamo™ titration and more

License ID 124049905 Program version tiamo 1.1 - 32
Client name TITRATION14
User Metrohm 2005-10-21 13:57:52 UTC+2

Rate . . . . . maximum mL/min

PUMP **clean titration vessel**

Device
Device name . . . . . 855_1
Pumps
Tower 1
Pump(s) . . . . . 1+2
Action
Switch on . . . . . off
Switch off . . . . . off
Duration . . . . . on
Time . . . . . 10 s

PUMP **aspirate solution**

Device
Device name . . . . . 855_1
Pumps
Tower 1
Pump(s) 2
Action
Switch on . . . . . off
Switch off . . . . . off
Duration . . . . . on
Time . . . . . 3 s

LIFT **lift to shift position**

Device
Device name . . . . . 855_1
Target
Tower 1
Lift position . . . . . Shift position mm
Parameters
Lift rate . . . . . 25 mm/s

SERIES END **Series end track**

PUMP **fill vessel**

Device
Device name . . . . . 855_1
Pumps
Tower 1
Pump(s) 1
Action
Switch on . . . . . off
Switch off . . . . . off
Duration . . . . . on
Time . . . . . 20 s

tiamo™ titration and more

License ID	124049905	Program version	tiamo 1.1 - 32
Client name	TITRATION14		
User	Metrohm	2005-10-21	13:57:52 UTC+2

ERROR **Error track**

PUMP **empty vessel**

Device
- Device name . . . . . 855_1

Pumps
- Tower 1
- Pump(s) 2

Action
- Switch on . . . . . off
- Switch off . . . . . off
- Duration . . . . . on
- Time . . . . . 10.0 s

PUMP **add water to vessel**

Device
- Device name . . . . . 855_1

Pumps
- Tower 1
- Pump(s) 1

Action
- Switch on . . . . . off
- Switch off . . . . . off
- Duration . . . . . on
- Time . . . . . 20 s

6.5 Determination of c(NaOH) = 0.1 mol/L

tiamo™ titration and more

License ID	124049905	Program version	tiamo 1.1 - 32
Client name	TITRATION14		
User	Metrohm	2005-10-21	14:04:17 UTC+2

Method parameters

Method . . . . . Determination of c(NaOH) = 0.1 M
Method saving date . . . . . 2005-10-21 14:04:12 UTC+2
Method version 1
Method group . . . . . Robotic Transfer Analyzer
Method status . . . . . original
Method saved by (full name) . . . . . Metrohm
Method saved by (short name) . . . . . Metrohm

START **Main track**

General

Workplace view
Current view . . . . . on
Track view for live window
Live display 1 . . . . . Main track
Live display 2 . . . . . Main track
Statistics . . . . . off
Conditioning
Automatic conditioning . . . . . off

Application note

See attached documents

Method variables

Name	Type	Assignment	Value	Comment	Monitoring
Sample size	Number	Sample size		Sample size	off
Sample size unit	Text	Sample size unit		Sample size unit	off
Sample position	Number	Sample position		Sample position number	off
ID1	Text	ID1		Sample identification 1	off
ID2	Text	ID2		Sample identification 2	off
ID3	Text	ID3		Sample identification 3	off

Name . . . . . **Sample size**
Type . . . . . Number
Assignment . . . . . on. . . . . Sample size
Value . . . . . off. . . . . .
Check at start . . . . . on
Comment . . . . . Sample size
Variable monitoring . . . . . off
Lower limit . . . . . .
Upper limit . . . . . .
Message . . . . . .
Display message . . . . . on
Record message . . . . . on
Message by e-mail . . . . . off

Mail to	
Subject	Message from tiamo - Method 'New method 1' - Command 'Main track'
User	
Mail from	
SMTP Server	
POP3 Server	
Acoustic signal	off
Action	off
Stop determination	on
Stop determination and series	off

Name	**Sample position**
Type	Number
Assignment	on. Sample position
Value	off.
Check at start	on
Comment	Sample position number
Variable monitoring	off
Lower limit	
Upper limit	
Message	
Display message	on
Record message	on
Message by e-mail	off
Mail to	
Subject	Message from tiamo - Method 'New method 1' - Command 'Main track'
User	
Mail from	
SMTP Server	
POP3 Server	
Acoustic signal	off
Action	off
Stop determination	on
Stop determination and series	off

Name	**Sample size unit**
Type	Text
Assignment	on. Sample size unit
Value	off.
Check at start	on
Comment	Sample size unit

Name	**ID1**
Type	Text
Assignment	on. ID1

Value . . . . . off
Check at start . . . . . off
Comment . . . . . Sample identification 1

Name **ID2**
Type . . . . . Text
Assignment . . . . . on ID2
Value . . . . . off
Check at start . . . . . off
Comment . . . . . Sample identification 2

Name **ID3**
Type . . . . . Text
Assignment . . . . . on ID3
Value . . . . . off
Check at start . . . . . on
Comment . . . . . Sample identification 3

PUMP **add water**
Device
Device name . . . . . 855_1
Pumps
Tower 1
Pump(s) 1
Action
Switch on . . . . . off
Switch off . . . . . off
Duration . . . . . on
Time . . . . . 20 s

SEQUENCE **sample transfer**

LQH **compensate**
General/Hardware
Device
Device name . . . . . 855_1
Dosing device
Dosing device 2
Solution . . . . . Transfer
Parameters
Function . . . . . Compensate
Port 3

LQH **produce first air bubble**
General/Hardware
Device
Device name . . . . . 855_1
Dosing device

Dosing device 2
Solution . . . . . Transfer

Parameters

Function . . . . . Aspirate
Port 3
Volume . . . . . 0.2 mL
Rate . . . . . 5 mL/min

MOVE **to sample**

Device
Device name . . . . . 855_1
Target
Tower 1
Move . . . . . Sample position
Beaker test
Display message . . . . . off
Stop determination . . . . . off
Stop determination and series . . . . . on
Parameters
Shift rate . . . . . 20 °/s
Shift direction . . . . . auto
Swing rate . . . . . 55 °/s

LIFT **lift to working position**

Device
Device name . . . . . 855_1
Target
Tower 1
Lift position . . . . . Work position mm
Parameters
Lift rate . . . . . 25 mm/s

LQH **aspirate sample**

General/Hardware

Device
Device name . . . . . 855_1
Dosing device
Dosing device 2
Solution . . . . . Transfer

Parameters

Function . . . . . Aspirate
Port 3
Volume . . . . . = 'MV.Sample size' mL
Rate . . . . . 5 mL/min

WAIT **adjusting pressure**

Wait
Stop track and waiting for [Continue] . . . . . off

Stop all tracks and waiting for [Continue] . . . . . off
Waiting time . . . . . on
Time 3
Unit . . . . . s
Message
Record message . . . . . off
Message by e-mail . . . . . off
Acoustic signal . . . . . off

LIFT **lift to shifting position**
Device
Device name . . . . . 855_1
Target
Tower 1
Lift position . . . . . Shift position mm
Parameters
Lift rate . . . . . 25 mm/s

LQH **produce second air bubble**
General/Hardware
Device
Device name . . . . . 855_1
Dosing device
Dosing device 2
Solution . . . . . Transfer
Parameters
Function . . . . . Aspirate
Port 3
Volume . . . . . 0.2 mL
Rate . . . . . 5 mL/min

LQH **change port**
General/Hardware
Device
Device name . . . . . 855_1
Dosing device
Dosing device 2
Solution . . . . . Transfer
Parameters
Function . . . . . Change port
Port 2

SWING **move to external position**
Device
Device name . . . . . 855_1
Target
Tower 1
Swing . . . . . External position

Number 1
Parameters
Swing rate . . . . . 55 °/s

LIFT **go down to work position**
Device
Device name . . . . . 855_1
Target
Tower 1
Lift position . . . . . Work position mm
Parameters
Lift rate . . . . . 25 mm/s

LQH **compensation**
General/Hardware
Device
Device name . . . . . 855_1
Dosing device
Dosing device 2
Solution . . . . . Transfer
Parameters
Function . . . . . Compensate
Port 3

LQH **dose sample**
General/Hardware
Device
Device name . . . . . 855_1
Dosing device
Dosing device 2
Solution . . . . . Transfer
Parameters
Function . . . . . Dosing
Port 3
Volume . . . . . 8 mL
Rate . . . . . 10 mL/min

WAIT **pressure adjustment**
Wait
Stop track and waiting for [Continue] . . . . . off
Stop all tracks and waiting for [Continue] . . . . . off
Waiting time . . . . . on
Time 3
Unit . . . . . s
Message
Record message . . . . . off
Message by e-mail . . . . . off
Acoustic signal . . . . . off

tiamo™ titration and more

License ID	124049905	Program version	tiamo 1.1 - 32
Client name	TITRATION14		
User	Metrohm	2005-10-21	14:04:17 UTC+2

LIFT **to shifting position**

Device
- Device name . . . . . 855_1

Target
- Tower 1
- Lift position . . . . . Shift position mm

Parameters
- Lift rate . . . . . 25 mm/s

DET pH **DET pH**

General/Hardware

Device
- Device name . . . . . 855_1

Dosing device
- Dosing device 1
- Solution . . . . . HCl

Sensor
- Measuring input 1
- Sensor . . . . . Aquatrode Plus
- Temperature measurement . . . . . automatic

Stirrer
- Stirrer 1
- Stirring rate 8
- Switch off automatically . . . . . on

Start conditions

Initial measured value
- Signal drift . . . . . off mV/min
- Min. waiting time . . . . . 0 s
- Max. waiting time . . . . . 1 s

Start volume
- Start volume . . . . . 0.5 mL
- Dosing rate . . . . . maximum mL/min

Start measured value
- Start measured value pH . . . . . off
- Dosing rate . . . . . 5 mL/min

Start slope
- Start slope . . . . . off pH/mL
- Dosing rate . . . . . 5 mL/min

Pause
- Pause . . . . . 5 s

Titration parameters

Titration rate
- Titration rate . . . . . user

Measured value acceptance
- Signal drift . . . . . 50.0 mV/min
- Min. waiting time . . . . . 0 s

Max. waiting time . . . . . 26 s
Dosing of increments
Measuring point density 4
Min. increment . . . . . 100 µL
Max. increment . . . . . off µL
Dosing rate . . . . . maximum mL/min
Temperature
Temperature . . . . . 25.0 °C
Stop conditions
Stop volume . . . . . 20 mL
Stop measured value pH . . . . . off
Stop EP 1
Volume after EP . . . . . 1.5 mL
Stop time . . . . . off s
Filling rate . . . . . maximum mL/min
Potentiometric evaluation
Evaluation without window . . . . . on
EP criterion 5
EP recognition . . . . . all
Evaluation with measured value window (pH) . . . . . off
Evaluation with volume window (mL) . . . . . off
Additional evaluations
Fix end point evaluation . . . . . off
pK/HNP evaluation . . . . . off
Minimum evaluation . . . . . off
Maximum evaluation . . . . . off
Break point evaluation . . . . . off
Additional measured values
Additional calculated measured values . . . . . off
Additional external measured values . . . . . off

SEQUENCE **clean vessel**

LIFT **down to working position**
Device
Device name . . . . . 855_1
Target
Tower 1
Lift position . . . . . Work position mm
Parameters
Lift rate . . . . . 25 mm/s

LQH **empty burette**
General/Hardware
Device
Device name . . . . . 855_1
Dosing device
Dosing device 2

tiamo™ titration and more

License ID 124049905 Program version tiamo 1.1 - 32
Client name TITRATION14
User Metrohm 2005-10-21 14:04:17 UTC+2

Solution . . . . . Transfer

Parameters

Function . . . . . Eject to end volume
Port 3
Rate . . . . . maximum mL/min

PUMP **aspirate sample solution**

Device
Device name . . . . . 855_1
Pumps
Tower 1
Pump(s) 2
Action
Switch on . . . . . off
Switch off . . . . . off
Duration . . . . . on
Time . . . . . 10.0 s

PUMP **rinse and aspirate**

Device
Device name . . . . . 855_1
Pumps
Tower 1
Pump(s) . . . . . 1+2
Action
Switch on . . . . . off
Switch off . . . . . off
Duration . . . . . on
Time . . . . . 7 s

PUMP **empty beaker**

Device
Device name . . . . . 855_1
Pumps
Tower 1
Pump(s) 2
Action
Switch on . . . . . off
Switch off . . . . . off
Duration . . . . . on
Time . . . . . 3 s

LIFT **go to shift position**

Device
Device name . . . . . 855_1
Target
Tower 1
Lift position . . . . . Shift position mm

Parameters

Lift rate . . . . . 25 mm/s

EXIT **Exit track**

CALC **calculation**

Result name	Formula	Unit	Decimal places	Assignment	Statistics
Content	= 'DET pH.EP{1}.VOL' * 'DET pH.CONC' * 'DET pH.TITER' / 'MV.Sample size'	mol/L	4	RS01	off

Result name . . . . . **Content**
Formula . . . . . = 'DET pH.EP{1}.VOL' * 'DET pH.CONC' * 'DET pH.TITER' / 'MV.Sample size'
Unit . . . . . mol/L
Decimal places 4
Assignment RS01
Statistics . . . . . off
Description . . . . . RS.'Result name'[.VAL]Result value.
Result monitoring . . . . . off
Save result as common variable . . . . . off
Name . . . . .
Save result as titer . . . . . off
Solution name . . . . .

REPORT **report**

Report template
Report template . . . . . Determination of c(NaOH) = 0.1 M
Report output
Printer . . . . . off
PDF file . . . . . on
PDF file . . . . . C:\Programme\Metrohm\tiamo\DET NaOH 0.1 M.pdf
Send e-mail . . . . . off

DATABASE **database**

Database

Robotic Transfer Analyzer

SERIES START **Series start track**

RACK **initialize rack**

Device
Device name . . . . . 855_1
Rack test . . . . . off

SEQUENCE **prepare vessel and dosino**

tiamo™ titration and more

License ID	124049905	Program version	tiamo 1.1 - 32
Client name	TITRATION14		
User	Metrohm	2005-10-21	14:04:17 UTC+2

SWING **swing to titration vessel**

Device
- Device name . . . 855_1

Target
- Tower . . . 1
- Swing . . . External position
- Number . . . 1

Parameters
- Swing rate . . . 55 °/s

PUMP **empty titration vessel**

Device
- Device name . . . 855_1

Pumps
- Tower . . . 1
- Pump(s) . . . 2

Action
- Switch on . . . off
- Switch off . . . off
- Duration . . . on
- Time . . . 10 s

LIFT **lift to work position**

Device
- Device name . . . 855_1

Target
- Tower . . . 1
- Lift position . . . Work position mm

Parameters
- Lift rate . . . 25 mm/s

PREP **prepare dosino**

Device
- Device name . . . 855_1

Dosing device
- Dosing device . . . 2
- Solution . . . Transfer

LQH **eject to end volume**

General/Hardware
- Device
  - Device name . . . 855_1
- Dosing device
  - Dosing device . . . 2
  - Solution . . . Transfer

Parameters
- Function . . . Eject to end volume
- Port . . . 3

Rate . . . . . maximum mL/min

PUMP **clean titration vessel**

Device
- Device name . . . . . 855_1

Pumps
- Tower 1
- Pump(s) . . . . . 1+2

Action
- Switch on . . . . . off
- Switch off . . . . . off
- Duration . . . . . on
- Time . . . . . 10 s

PUMP **aspirate solution**

Device
- Device name . . . . . 855_1

Pumps
- Tower 1
- Pump(s) 2

Action
- Switch on . . . . . off
- Switch off . . . . . off
- Duration . . . . . on
- Time . . . . . 3 s

LIFT **lift to shift position**

Device
- Device name . . . . . 855_1

Target
- Tower 1
- Lift position . . . . . Shift position mm

Parameters
- Lift rate . . . . . 25 mm/s

SERIES END **Series end track**

PUMP **fill vessel**

Device
- Device name . . . . . 855_1

Pumps
- Tower 1
- Pump(s) 1

Action
- Switch on . . . . . off
- Switch off . . . . . off
- Duration . . . . . on
- Time . . . . . 20 s

tiamo™ titration and more

License ID	124049905	Program version	tiamo 1.1 - 32
Client name	TITRATION14		
User	Metrohm	2005-10-21	14:04:17 UTC+2

ERROR **Error track**

PUMP **empty vessel**

Device
- Device name . . . . . 855_1

Pumps
- Tower 1
- Pump(s) 2

Action
- Switch on . . . . . off
- Switch off . . . . . off
- Duration . . . . . on
- Time . . . . . 10.0 s

PUMP **add water to vessel**

Device
- Device name . . . . . 855_1

Pumps
- Tower 1
- Pump(s) 1

Action
- Switch on . . . . . off
- Switch off . . . . . off
- Duration . . . . . on
- Time . . . . . 20 s

6.6 Determination of c(NH_4OH) = 0.1 mol/L

tiamo™ titration and more

License ID	124049905	Program version	tiamo 1.1 - 32
Client name	TITRATION14		
User	Metrohm	2005-10-21	14:07:35 UTC+2

Method parameters

Method . . . . . Determination of c(NH4OH) = 0.1 M
Method saving date . . . . . 2005-10-21 14:07:29 UTC+2
Method version 1
Method group . . . . . Robotic Transfer Analyzer
Method status . . . . . original
Method saved by (full name) . . . . . Metrohm
Method saved by (short name) . . . . . Metrohm

START **Main track**

General

Workplace view
Current view . . . . . on
Track view for live window
Live display 1 . . . . . Main track
Live display 2 . . . . . Main track
Statistics . . . . . on
Number of single determinations . . . . . not defined
Conditioning
Automatic conditioning . . . . . off

Application note

See attached documents

Method variables

Name	Type	Assignment	Value	Comment	Monitoring
Sample size	Number	Sample size		Sample size	off
Sample size unit	Text	Sample size unit		Sample size unit	off
Sample position	Number	Sample position		Sample position number	off
ID1	Text	ID1		Sample identification 1	off
ID2	Text	ID2		Sample identification 2	off
ID3	Text	ID3		Sample identification 3	off

Name . . . . . **Sample size**
Type . . . . . Number
Assignment . . . . . on . . . . . Sample size
Value . . . . . off . . . . .
Check at start . . . . . on
Comment . . . . . Sample size
Variable monitoring . . . . . off
Lower limit . . . . .
Upper limit . . . . .
Message . . . . .
Display message . . . . . on
Record message . . . . . on

Message by e-mail . . . . . off
Mail to . . . . .
Subject . . . . . Message from tiamo - Method 'New method 1' - Command 'Main track'
User . . . . .
Mail from . . . . .
SMTP Server . . . . .
POP3 Server . . . . .
Acoustic signal . . . . . off
Action . . . . . off
Stop determination . . . . . on
Stop determination and series . . . . . off

Name . . . . . **Sample position**
Type . . . . . Number
Assignment . . . . . on . . . . . Sample position
Value . . . . . off . . . . .
Check at start . . . . . on
Comment . . . . . Sample position number
Variable monitoring . . . . . off
Lower limit . . . . .
Upper limit . . . . .
Message . . . . .
Display message . . . . . on
Record message . . . . . on
Message by e-mail . . . . . off
Mail to . . . . .
Subject . . . . . Message from tiamo - Method 'New method 1' - Command 'Main track'
User . . . . .
Mail from . . . . .
SMTP Server . . . . .
POP3 Server . . . . .
Acoustic signal . . . . . off
Action . . . . . off
Stop determination . . . . . on
Stop determination and series . . . . . off

Name . . . . . **Sample size unit**
Type . . . . . Text
Assignment . . . . . on . . . . . Sample size unit
Value . . . . . off . . . . .
Check at start . . . . . on
Comment . . . . . Sample size unit

Name **ID1**
Type . . . . . Text

Assignment . . . . . on. ID1
Value . . . . . off. . . . . .
Check at start . . . . . off
Comment . . . . . Sample identification 1

Name **ID2**
Type . . . . . Text
Assignment . . . . . on. ID2
Value . . . . . off. . . . . .
Check at start . . . . . off
Comment . . . . . Sample identification 2

Name **ID3**
Type . . . . . Text
Assignment . . . . . on. ID3
Value . . . . . off. . . . . .
Check at start . . . . . on
Comment . . . . . Sample identification 3

PUMP **add water**

Device
Device name . . . . . 855_1
Pumps
Tower 1
Pump(s) 1
Action
Switch on . . . . . off
Switch off . . . . . off
Duration . . . . . on
Time . . . . . 20 s

SEQUENCE **sample transfer**

LQH **compensate**

General/Hardware

Device
Device name . . . . . 855_1
Dosing device
Dosing device 2
Solution . . . . . Transfer

Parameters

Function . . . . . Compensate
Port 3

LQH **produce first air bubble**

General/Hardware

Device
Device name . . . . . 855_1

Dosing device
Dosing device 2
Solution . . . . . Transfer
Parameters
Function . . . . . Aspirate
Port 3
Volume . . . . . 0.1 mL
Rate . . . . . 5 mL/min

MOVE **to sample**
Device
Device name . . . . . 855_1
Target
Tower 1
Move . . . . . Sample position
Beaker test
Display message . . . . . off
Stop determination . . . . . off
Stop determination and series . . . . . on
Parameters
Shift rate . . . . . 20 °/s
Shift direction . . . . . auto
Swing rate . . . . . 55 °/s

LIFT **lift to working position**
Device
Device name . . . . . 855_1
Target
Tower 1
Lift position . . . . . Work position mm
Parameters
Lift rate . . . . . 25 mm/s

LQH **aspirate sample**
General/Hardware
Device
Device name . . . . . 855_1
Dosing device
Dosing device 2
Solution . . . . . Transfer
Parameters
Function . . . . . Aspirate
Port 3
Volume . . . . . = 'MV.Sample size' mL
Rate . . . . . 5 mL/min

WAIT **adjusting pressure**
Wait

Stop track and waiting for [Continue] . . . . . off
Stop all tracks and waiting for [Continue] . . . . . off
Waiting time . . . . . on
Time 3
Unit . . . . . s
Message
Record message . . . . . off
Message by e-mail . . . . . off
Acoustic signal . . . . . off

LIFT **lift to shifting position**
Device
Device name . . . . . 855_1
Target
Tower 1
Lift position . . . . . Shift position mm
Parameters
Lift rate . . . . . 25 mm/s

LQH **produce second air bubble**
General/Hardware
Device
Device name . . . . . 855_1
Dosing device
Dosing device 2
Solution . . . . . Transfer
Parameters
Function . . . . . Aspirate
Port 3
Volume . . . . . 0.1 mL
Rate . . . . . 5 mL/min

LQH **change port**
General/Hardware
Device
Device name . . . . . 855_1
Dosing device
Dosing device 2
Solution . . . . . Transfer
Parameters
Function . . . . . Change port
Port 2

SWING **move to external position**
Device
Device name . . . . . 855_1
Target
Tower 1

tiamo™ titration and more

License ID 124049905 Program version tiamo 1.1 - 32
Client name TITRATION14
User Metrohm 2005-10-21 14:07:35 UTC+2

Swing . . . . . External position
Number 1
Parameters
Swing rate . . . . . 55 °/s

LIFT **go down to work position**
Device
Device name . . . . . 855_1
Target
Tower 1
Lift position . . . . . Work position mm
Parameters
Lift rate . . . . . 25 mm/s

LQH **compensation**
General/Hardware
Device
Device name . . . . . 855_1
Dosing device
Dosing device 2
Solution . . . . . Transfer
Parameters
Function . . . . . Compensate
Port 3

LQH **dose sample**
General/Hardware
Device
Device name . . . . . 855_1
Dosing device
Dosing device 2
Solution . . . . . Transfer
Parameters
Function . . . . . Dosing
Port 3
Volume . . . . . 8 mL
Rate . . . . . 10 mL/min

WAIT **pressure adjustment**
Wait
Stop track and waiting for [Continue] . . . . . off
Stop all tracks and waiting for [Continue] . . . . . off
Waiting time . . . . . on
Time 3
Unit . . . . . s
Message
Record message . . . . . off
Message by e-mail . . . . . off

Acoustic signal . . . . . off

LIFT **to shifting position**

Device

Device name . . . . . 855_1

Target

Tower 1

Lift position . . . . . Shift position mm

Parameters

Lift rate . . . . . 25 mm/s

DET pH **DET pH**

General/Hardware

Device

Device name . . . . . 855_1

Dosing device

Dosing device 1

Solution . . . . . HCl

Sensor

Measuring input 1

Sensor . . . . . Aquatrode Plus

Temperature measurement . . . . . automatic

Stirrer

Stirrer 1

Stirring rate 8

Switch off automatically . . . . . on

Start conditions

Initial measured value

Signal drift . . . . . off mV/min

Min. waiting time . . . . . 0 s

Max. waiting time . . . . . 1 s

Start volume

Start volume . . . . . 0.5 mL

Dosing rate . . . . . maximum mL/min

Start measured value

Start measured value pH . . . . . off

Dosing rate . . . . . 5 mL/min

Start slope

Start slope . . . . . off pH/mL

Dosing rate . . . . . 5 mL/min

Pause

Pause . . . . . 5 s

Titration parameters

Titration rate

Titration rate . . . . . user

Measured value acceptance

Signal drift . . . . . 50.0 mV/min

Min. waiting time . . . . . 0 s
Max. waiting time . . . . . 26 s
Dosing of increments
Measuring point density 4
Min. increment . . . . . 50 µL
Max. increment . . . . . off µL
Dosing rate . . . . . maximum mL/min
Temperature
Temperature . . . . . 25.0 °C

Stop conditions

Stop volume . . . . . 20 mL
Stop measured value pH . . . . . off
Stop EP 1
Volume after EP . . . . . 1.5 mL
Stop time . . . . . off s
Filling rate . . . . . maximum mL/min

Potentiometric evaluation

Evaluation without window . . . . . on
EP criterion 5
EP recognition . . . . . all
Evaluation with measured value window (pH) . . . . . off
Evaluation with volume window (mL) . . . . . off

Additional evaluations

Fix end point evaluation . . . . . off
pK/HNP evaluation . . . . . off
Minimum evaluation . . . . . off
Maximum evaluation . . . . . off
Break point evaluation . . . . . off

Additional measured values

Additional calculated measured values . . . . . off
Additional external measured values . . . . . off

SEQUENCE clean vessel

LIFT down to working position

Device
Device name . . . . . 855_1
Target
Tower 1
Lift position . . . . . Work position mm
Parameters
Lift rate . . . . . 25 mm/s

LQH empty burette

General/Hardware

Device
Device name . . . . . 855_1
Dosing device

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Dosing device 2
Solution . . . . . Transfer

Parameters

Function . . . . . Eject to end volume
Port 3
Rate . . . . . maximum mL/min

PUMP **aspirate sample solution**

Device
Device name . . . . . 855_1
Pumps
Tower 1
Pump(s) 2
Action
Switch on . . . . . off
Switch off . . . . . off
Duration . . . . . on
Time . . . . . 10.0 s

PUMP **rinse and aspirate**

Device
Device name . . . . . 855_1
Pumps
Tower 1
Pump(s) . . . . . 1+2
Action
Switch on . . . . . off
Switch off . . . . . off
Duration . . . . . on
Time . . . . . 7 s

PUMP **empty beaker**

Device
Device name . . . . . 855_1
Pumps
Tower 1
Pump(s) 2
Action
Switch on . . . . . off
Switch off . . . . . off
Duration . . . . . on
Time . . . . . 3 s

LIFT **go to shift position**

Device
Device name . . . . . 855_1
Target
Tower 1

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License ID 124049905 Program version tiamo 1.1 - 32
Client name TITRATION14
User Metrohm 2005-10-21 14:07:35 UTC+2

Lift position . . . . . Shift position mm
Parameters
Lift rate . . . . . 25 mm/s

EXIT **Exit track**

CALC **calculation**

Result name	Formula	Unit	Decimal places	Assignment	Statistics
Content	= 'DET pH.EP{1}.VOL' * 'DET pH.CONC' * 'DET pH.TITER' / 'MV.Sample size'	mol/L	4	RS01	off

Result name . . . . . **Content**
Formula . . . . . = 'DET pH.EP{1}.VOL' * 'DET pH.CONC' * 'DET pH.TITER' / 'MV.Sample size'
Unit . . . . . mol/L
Decimal places 4
Assignment RS01
Statistics . . . . . off
Description . . . . . RS.'Result name'[.VAL]Result value.
Result monitoring . . . . . off
Save result as common variable . . . . . off
Name . . . . .
Save result as titer . . . . . off
Solution name . . . . .

REPORT **report**
Report template
Report template . . . . . Determination of c(NH4OH) = 0.1 M
Report output
Printer . . . . . off
PDF file . . . . . on
PDF file . . . . . C:\Programme\Metrohm\tiamo\DET NH4OH 0.1 M.pdf
Send e-mail . . . . . off

DATABASE **database**

Database

Robotic Transfer Analyzer

SERIES START **Series start track**

RACK **initialize rack**
Device
Device name . . . . . 855_1
Rack test . . . . . off

tiamo™ titration and more

License ID	124049905	Program version	tiamo 1.1 - 32
Client name	TITRATION14		
User	Metrohm	2005-10-21	14:07:35 UTC+2

SEQUENCE **prepare vessel and dosino**

SWING **swing to titration vessel**

Device
- Device name . . . . . 855_1

Target
- Tower 1
- Swing . . . . . External position
- Number 1

Parameters
- Swing rate . . . . . 55 °/s

PUMP **empty titration vessel**

Device
- Device name . . . . . 855_1

Pumps
- Tower 1
- Pump(s) 2

Action
- Switch on . . . . . off
- Switch off . . . . . off
- Duration . . . . . on
- Time . . . . . 10 s

LIFT **lift to work position**

Device
- Device name . . . . . 855_1

Target
- Tower 1
- Lift position . . . . . Work position mm

Parameters
- Lift rate . . . . . 25 mm/s

PREP **prepare dosino**

Device
- Device name . . . . . 855_1

Dosing device
- Dosing device 2
- Solution . . . . . Transfer

LQH **eject to end volume**

General/Hardware
- Device
  - Device name . . . . . 855_1
- Dosing device
  - Dosing device 2
  - Solution . . . . . Transfer

Parameters

Function . . . . . Eject to end volume
Port 3
Rate . . . . . maximum mL/min

PUMP **clean titration vessel**

Device
Device name . . . . . 855_1
Pumps
Tower 1
Pump(s) . . . . . 1+2
Action
Switch on . . . . . off
Switch off . . . . . off
Duration . . . . . on
Time . . . . . 10 s

PUMP **aspirate solution**

Device
Device name . . . . . 855_1
Pumps
Tower 1
Pump(s) 2
Action
Switch on . . . . . off
Switch off . . . . . off
Duration . . . . . on
Time . . . . . 3 s

LIFT **lift to shift position**

Device
Device name . . . . . 855_1
Target
Tower 1
Lift position . . . . . Shift position mm
Parameters
Lift rate . . . . . 25 mm/s

SERIES END **Series end track**

PUMP **fill vessel**

Device
Device name . . . . . 855_1
Pumps
Tower 1
Pump(s) 1
Action
Switch on . . . . . off
Switch off . . . . . off

Duration . . . . . on
Time . . . . . 20 s

ERROR **Error track**

PUMP **empty vessel**

Device
Device name . . . . . 855_1
Pumps
Tower 1
Pump(s) 2
Action
Switch on . . . . . off
Switch off . . . . . off
Duration . . . . . on
Time . . . . . 10.0 s

PUMP **add water to vessel**

Device
Device name . . . . . 855_1
Pumps
Tower 1
Pump(s) 1
Action
Switch on . . . . . off
Switch off . . . . . off
Duration . . . . . on
Time . . . . . 20 s

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