Step motor burette

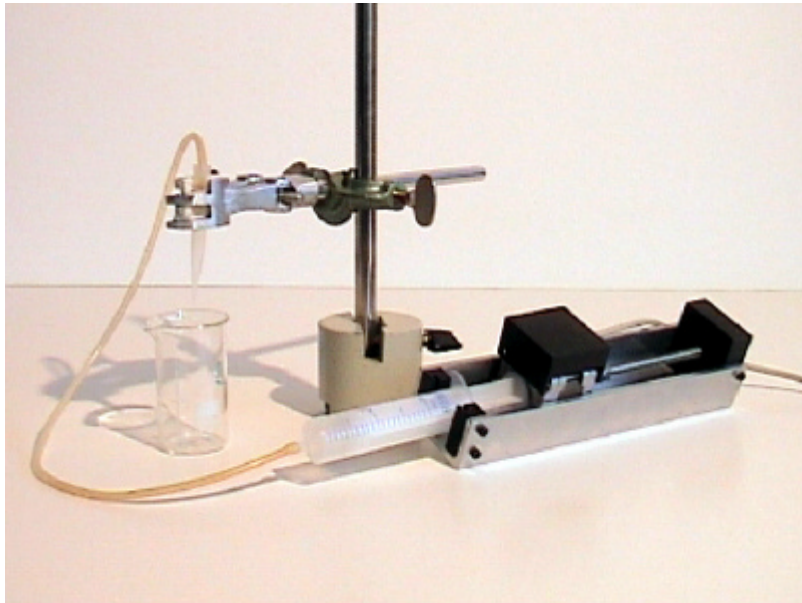# (for CoachLab or CoachLab II interface)

Description D012

Figure 1. The Step motor burette

Short description

CMA step motor burette (titrator) is a cheap, accurate, dosage device that can be used to control, with the help of computer and an interface, a process of adding a titrant in titration experiments. The titrator uses outputs of CoachLab of CoachLab II interface. In the Coach 5 software these outputs are controlled with control instructions.
For titration experiments the pH, temperature or conductivity sensor can be connected to inputs of the measuring interface.

The type of the syringe is not so critical. Disposable syringe is accurate enough. The tip where the droplets flow out influences the accuracy of the titration more.

The volume of a droplet from the delivered pipette is 0.02 ml.

The titrator is delivered with 2x 20-ml syringe, 2x 40-cm plastic tube and 2x micro-pipette.

Where to find activities for the step motor burette

The activities 'Calibration - step motor burette' and 'Acid base titration with the CMA burette' are included in following Coach 5 products:

- **'Coach 5 Junior for CMA interfaces'** - which can be install **freely** from the Coach 5 CD. Activities can be found in the project: CoachLab II: 1. Measurement examples.

- **'Coach 5 Basic'** and **'Coach 5 Full'** - which can be installed with the license code from the Coach 5 CD. Activities can be found in the 'Exploring Chemistry' project.

Note: The control program works very slow under Windows NT.

Connecting the titrator to CoachLab or CoachLab II

The four wires of the titrator are connected to four (blue) outputs of the CoachLab I or to four lower outputs of the CoachLab II (see picture below):

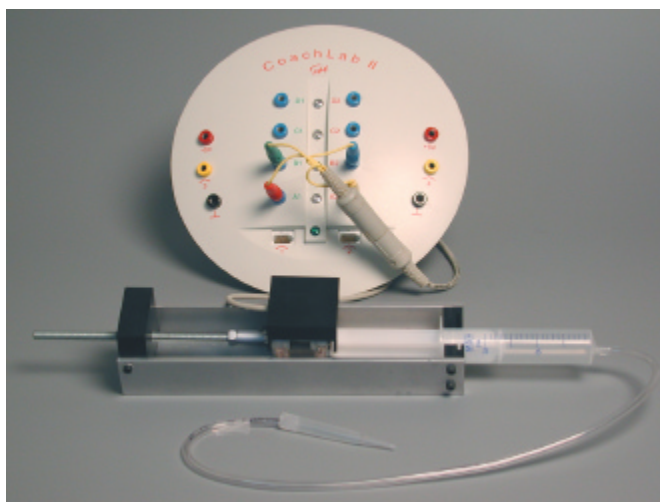| Color	CoachLab	CoachLab II
Red	1 (A)	A1
Yellow	2 (A)	A2
Green	3 (B)	B1
Blue	4 (B)	B2

Figure 2. Connecting the titrator to CoachLab II interface.

A mnemonic: connect the wires in the order of the rainbow colors (red, yellow, green and blue).

Placing/changing the syringe

- Lift the block with the spindle. Let the small black element turn by hitting it a few times at the edge until it is about 3 cm away from the nut. Place the block back.
- Fill the syringe (with plastic tube) up to 22 ml (a little bit more then the scale division shows). Remove air from the syringe.
- Place the syringe in the titrator and plug the plastic tube in the pipette.
- Turn the spindle until the syringe is fixed and droplets start to come out of the tube.

Calibration

With the following calibration the number of steps per millimeter is determined:

- Connect the CoachLab of CoachLab II interface. Check whether the mains adapter is set to 12 V.
- Open an activity: **Calibration of step motor burette.**
- Fill the syringe with water.
- Control the presence of a droplet on the pipette. Remove the droplet.
- Weigh an empty glass (100-ml) and place it under the pipette.
- Start the titrator with the (green) start button.
  The rotational speed of the motor is under Windows 95/98 considerable higher then under Windows NT4.
- Stop the titrator when 6500 steps are made.
- Determine the mass of the water in the glass. This determines the volume of the water (V).
- Read the exact number of steps (S) from the graph.
- The calibration factor S/V is (in steps/ml). Write down this value.
- Repeat this calibration few times and determine an average calibration factor.

A typical value for the delivered syringe is 660 [±2] steps/ml. Also use the program to empty the syringe in 5-ml portions. This gives you an indication of the reproducibility over the whole range of the syringe. In all tests the error margin was less then 0.5 %.

General remarks for performing a titration

It is recommended to use magnetic stirrer (with stirring bar) and small beaker (maximum 100-ml).
The quality of the equivalence point strongly depends on the mixing of the solutions during the titration. For best results reduce the volume in the reaction vessel as much as possible (<40 ml) and stir thoroughly.

Use utility clamps to suspend a pH electrode and pipette on a ring stand. Situate the pH electrode on the solution and adjust its position toward the outside of the beaker so that it is not struck by stirring bar. The sensor should stay permanent in contact with the solution.

Figure 3. Experimental setup

Performing a titration

- Connect the CoachLab of CoachLab II and start the Coach. Check whether the mains adapter is set to 12 V (only for adjustable adapters).
- Select an activity: **Acid base titration with the CMA burette**.
- Click the P-button to see a list with commands and the program.
- Check/change the value behind **[Step/ml]**. If the program doesn't contain the calibration factor then the value of 660 steps/ml is taken.
- Select the titrator actions from the command list (see examples below). Program is created by selecting commands from the command list.
  - Use <Del> to delete a line.
  - Use <Ins> to add an empty line.
  - With <Enter> you can change a line.
- Press the green button to start the Monitor window.
- Click the green button in the Monitor window to execute the program.

<u>**Example 1**</u>

Titrate (15; Slow)
MotorBack(15)

This program moves syringe so that 15-ml of liquid is added and then moves motor back for the same distance.

Example 1

Titrate (10; Fast)
Titrate (2.5; Slow)
**Titrate (2.5; Medium)**
MotorBack(15)

This program works similar as the first one but now is known that the equivalence point is reached when 11.2 ml of liquid is added.

Example

The results of titration of 0.1 M of acetic acid with 0.1M of NaOH is shown in the graph.
The acetic acid is lightly polluted with sulfuric acid.
This can be seen from the derivative (gray) of the titration curve.
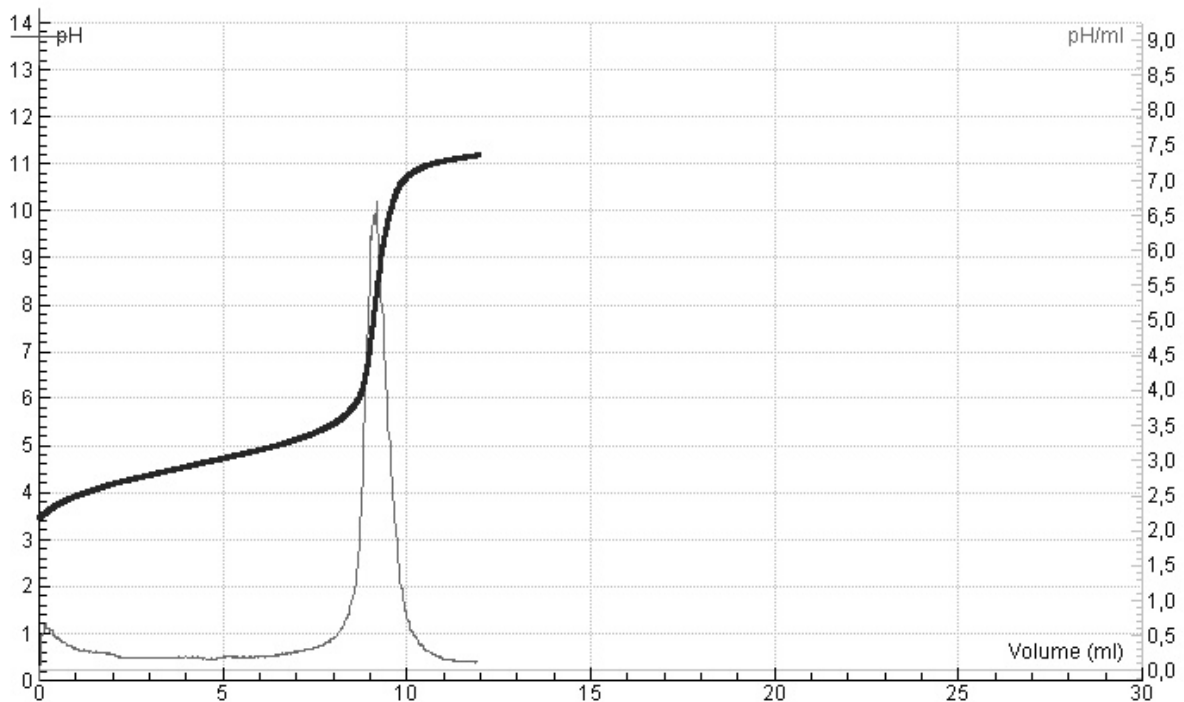
What to do when the CMA Step motor burette is not working correctly

A. Control the connection of the titrator to Coach Lab I or CoachLab II.
The titrator works properly only when it is connected to CoachLab interface in a way as described in the paragraph '**Connecting the titrator to CoachLab or CoachLab II'.**

B. Control the mains adapter of the CoachLab I or CoachLab II.
The titrator is powered by 12 V. Check whether the mains adapter is set to 12 V (if you have an adjustable mains adapter).

C. Increase the Waiting time between steps (only for Windows 95/98).
If the steps follow each other too quickly 'hiccups' may occur as soon as the syringe is pressed.
This problem appears sometimes in Windows 95/98 when the command **Titrate (…;Fast)** is used. For slow titration for example **Titrate (…;Slow)** the step motor burette should function properly.

If fast titration is required anyway increase the Waiting time between the steps. This is only possible in Author mode of Coach 5.
- Start the activity: **Acid base titration with the CMA burette**.
- Click the Programming window.
- Place the mouse cursor on the bottom line off the title bar until it changes its shape (see picture).
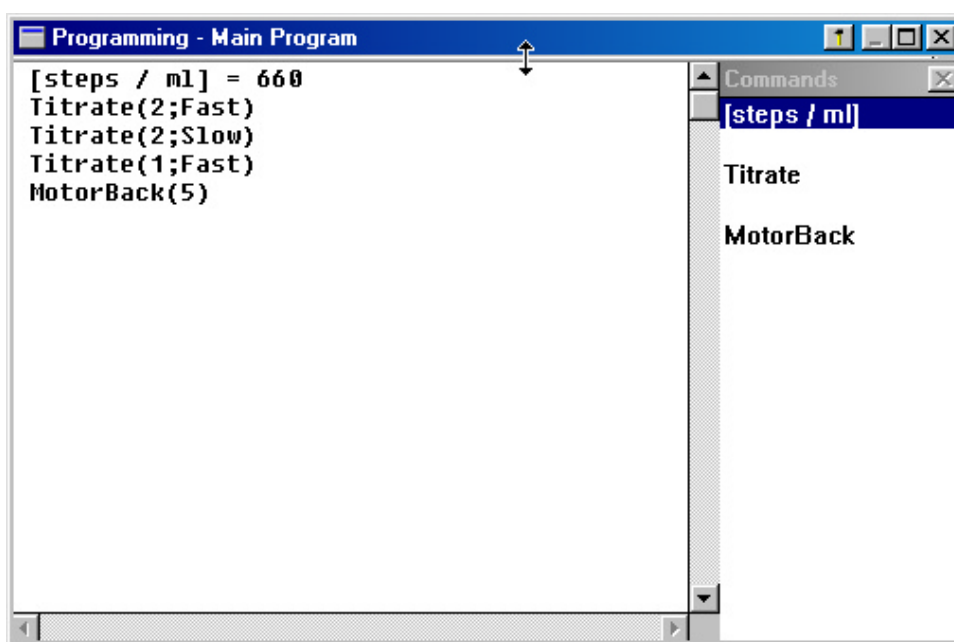
- Drag the top edge down.
  The Micro world editor window with procedures defined for the titrator opens.
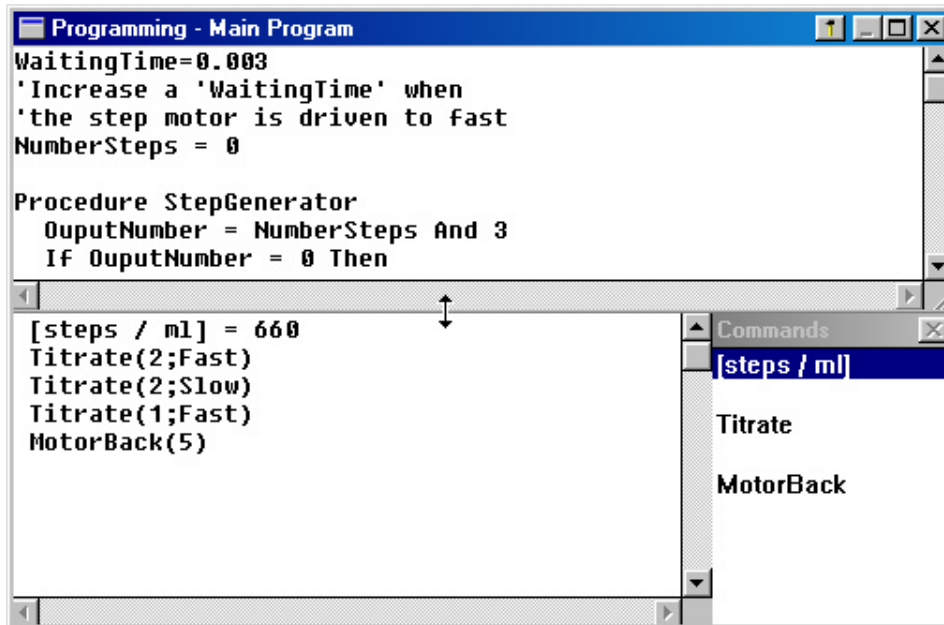
- Increase the value of WaitingTime (for instance 0.005)
- Close the Micro world editor window.
- Save the activity.
- Check or the **Titrate (…;Fast)** command works correct after changes.