chemcode®

chemical pocket calculator

mobile and fast calculations
in chemistry and life sciences

Manual

digi norm® elektronik

diginorm elektronik

and

Peter Barthel & Wilhelm Schmidthals GmbH

BS

Important Notice

1) The calculator switches off automatically two minutes after the last input. The last input of a

- compound formula
  or a
- sequence of nucleotides

  is memorized automatically and displayed again after switching on the calculator and entering into a menu.

2) If troubles should occur during operation (e.g. caused by a strong electrical field):

   press the key “**on**“ (reset).

   Afterwards the calculator can be operated as usual. The last compound formula / sequence of nucleotides put in will appear again in the display after entering a menu.

   See chapter 9.1 explaining the automatic memory function.

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Please keep this manual always carefully together with your chemcode®!

chemcode ®

chemcode® – chemical pocket calculator
Mobile and fast calculations in chemistry and life sciences
Manual

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Introduction

Thank you very much for your confidence in our product, the chemical pocket calculator chemcode®!

We are sure of having delivered a valuable tool of great use. Stoichiometric calculations of your daily lab routine will be decisively simplified with this innovative product.
Everybody having to deal frequently with stoichiometric standard calculations will soon appreciate the chemcode® as an indispensable companion for educational and professional purposes.

Please make yourself acquainted with the functions of the calculator by studying this manual before use. You will quickly achieve routine in operating the chemcode®. Operation is easy and the display is self-explaining to a high degree. Should there be, however, any troubles in understanding a function you surely will find the answer to your problem in this manual.

You will find further informations about the project chemcode® in the internet adressing our website:

www.chemcode.com

There are also forms for giving us feedback, making proposals for the optimization of the chemcode® and for asking questions. Thus we will be able to make the chemcode® a still more attractive tool in the future.

We are looking forward to your feedback!

In representation of your chemcode®-team

Florian Ens – Dr. Robert Stark

Survey

Contents

1 GETTING STARTED – KEYBOARD STRUCTURE

1.1 LANGUAGE

All terms and abbreviations of the display, the case and the keyboard follow the usage of English language.
Explanation of abbreviations: See chapter 10.

1.2 TURN ON / OFF

← **On**: Press key "**on**"

Off: "**2nd**" and "**clr**" (second function of "**clr**") →

1.3 SECOND FUNCTION OF KEYS

A print above a key marks the second function of this key (except for prints on green lines). They are activated by pressing the key "**2nd**". Afterwards the symbol "2nd" appears in the top line of the display:

top line →
1st line →
2nd line →

```
     2nd
M1  Molar Mass
M = 0 g/mol
```

Second functions are disactivated by pressing the key "**2nd**" again (or by pressing any other key without second function) and the symbol "2nd" in the top line disappears.

After the execution of a key's second function (print above a key) the primary key functions (symbolized by the print on the key) are automatically reactivated and the symbol "2nd" in the top line vanishes.

Please note: Nickel (**Ni** ^{28}) is the second function of Selenium (**Se** ^{34}), "**Pd** ^{46}" of "**Te** ^{52}", and "**Pt** ^{78}" of "**Po** ^{84}". The three elements, that belong to transition group VIII in the periods 4, 5, 6 and 7 are enclosed by a white frame. Nevertheless every element symbol on the case is a second function of the key below of this symbol.

Example: Input of Fe_2O_3

Press key "**Cm**": The calculator changes to menu **M1**:

Line 1 →
Line 2 →

```
M1  Molar Mass
M = 0 g/mol
```

Note: This example deals with the case, that the compound formula put in at last has been deleted by pressing the key "**clr**" (see ch. 3.2.1). If this has not been the case, the last compound formula put in would be visible in line 2.
See p. 22, ch. 5.2 step 2a and 2b.

Press key "**2nd**" – the symbol "2nd" appears in the top line:

Top line →
Line 1 →
Line 2 →

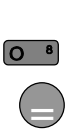
```
    2nd
M1  Molar Mass
M = 0 g/mol
```

Press key "**Co** ^{27}": Its second function "**Fe** ^{26}" has been activated before by pressing the key "**2nd**": Display:

- Top line: symbol "2nd" disappears.
- line 1: **Fe**
- line 2: molar mass of Fe: **55.847 g/mol**

Top line →
Line 1 →
Line 2 →

```
M1  Fe
M = 55.847 g/mol
```



- Press key "**2**" for the subscript of „Fe" in Fe_2O_3
- Press key "**O** ^{8}"
- Press key "**3**" (subscript of „O" in Fe_2O_3)
- Press key " **=** ". The result is shown in the display:

Top line →
Line 1 →
Line 2 →

```
M1  Fe2O3
M = 159.692 g/mol
```

Further details: See ch. 5.2.

1.4 PERIODIC SYSTEM KEYBOARD (WITH KEYS FOR NUCLEOTIDES OF DNA / RNA)

VIII b

All letters and numbers on the green lines of the case serve for orientation within the periodic system and do not mark second functions of keys (e.g. VIII b = transition group 8; further explanation see ch. 11.2).

- Elements of the main groups: ..... black letters

- Elements of transition groups: ..... white letters →

- Lanthanoides and actinoides: ..... blue letters

- Bases of DNA- / RNA-nucleotides: blue letters

  These are second functions of the keys from "**B** ^{5}" up to "**O** ^{8}", that are automatically active in the menus **GeD** und **GeR**. In these menus the key "**2nd**" must not be pressed!

2 MENU CONTROL

2.1 CALCULATOR MODE

After switching on (key "**on**") the device is always in the calculator mode. Zero signals in line 2:[1]

Line 1 →
Line 2 →

```
Calculator
0
```

As long as the device is in the caculator mode the letters "`Calculator`" appear in line 1.

In the calculator mode usual calculation operations can be performed by using the numerical and operation keys like with any other pocket calculator (see chapter 8).
By pressing the key "**Cm**" the device changes to menu **M1**.

[1] In this manual signalling of symbols in the display is graphically symbolized by underlining these symbols.

2.2 KEY “Cm“ (CHANGE MENU)

Pressing this key causes the device to change to the next menu (or from the calculator mode to menu **M1**). Each menu is symbolized by an abbrev. on the left side of line 1. This abbrev. lasts as long as the menu is not left:

Examples:
- **M** = molar mass
- **Sol** = solution
- Explanation of further abbreviations: See chapter 10.1

Order of menus: calculator mode, **M1**, **Sol**, **C1**, **T**, **D**, **F**, **P1**, **Lib**, **GeD**, **GeR**, calculator mode, **M1**, **Sol**, ...

Each menu (except menu **Lib** – Library) offers:

- a single chemical calculation or
- a group of submenus – each submenu for another calculation.

Each submenu is marked by a number following directly after the menu’s abbreviation. After change into a menu consisting of a group of submenus, the submenu with number “1“ appears at first.

The menus **GeD** (for DNA) and **GeR** (for RNA), however, are different. Though they have no number, they are the first submenus of two whole groups of submenus. In both groups only the following submenus (from the second on) are marked with numbers: **Ge1**, **Ge2**, etc.[1]

2.3 KEY “Sm“ (SUBMENU)

Pressing this key causes the device to change to the next submenu. After the last submenu the first one appears again.

Example: **C1**, **C2**, **C3**, then again **C1**, etc.

Graphic illustration of menu order: see chapter 4 (page 20).

[1] The submenus **Ge1** – **Ge6** of **GeD** and **GeR** are in principle identical. There are, however, some necessary differences: E.g. the base Uracil is used instead of Thymine during calculations.

2.4 KEY COMBINATION "2nd" AND "Cm"

Pressing these two keys causes the device to change to the preceding menu. Thus the menus can be entered the other way round :

Menu order: calculator mode, **GeR**, **GeD**, **Lib**, **P1**, **F**, **D**, **T**, **C1**, **Sol**, **M1**, calculator mode, **GeR**, **GeD**, ...

2.5 NAVIGATING THROUGH MENUS AND SUBMENUS

Within a menu or submenu the key " **=** " must be pressed in order to reach the next step in a menu. This could be:

- A new input / the affirmation of a displayed value
- Display of the result

Exception: Menus **Lib** and **Ge6**: Navigation by "scroll keys".

3 DISPLAY: STRUCTURE, INPUT, DELETING, SCROLLING

3.1 STRUCTURE AND DATA INPUT

3.1.1 Line 1

Top line →
Line 1 →
Line 2 →

```
M1  Molar Mass
M = 0 g/mol
```

← abbrev. (left) and name of the menu

a) **Left Side:** The menu's **abbreviation, e.g**. "**M1**" or "**Sol**".

b) **Right Side:** Alternatively:

1) The **menu's name**: e.g. "**Solution**" (when starting the menu);
2) A **compound formula** or a **nucleotide sequence**;
3) A **formula** or an **explanation**: e.g. "**n/V[mol/l] → m[g]**".

Exceptions:

- Calculator mode (see this ch., p. 12 under c).
- Menu **Lib**: The element's name appears (see p. 57).
- Menu **Ge6**: To the right there are the base tripletts by which a special amino acid is coded (see p. 69).

c) **Input into the right side of line 1 at menu start**

- **Compound formula** – menus **M1**–**M4**, **Sol**, **C1**–**C3**, **P1**–**P2**

line 1 ➔
line 2 ➔

```
M1  H2SO4
M = 98.0734 g/mol
```

A compound formula can also appear when memorized before (automatic memory or using the using the key "read memory").

Input: Change between element keys and numerical keys (for subscripts). Line 2: molar mass of the last element put in or of the whole compound after pressing the key " **=** ".

Usually the input of data is done when starting Menu **M1**. The compound formula put in will be automatically taken over by the other stoichiometric menus mentioned above. There it serves as the base for further calculations. This is not the case in the menus **T**, **D**, **F**, where other data than compound formulas serve as calculation base.

Compound formulas can be replaced in every menu mentioned above (not in **P3**–**P4**) by writing the new formula over the old one.

- **Nucleotide sequence** – menus **GeD** and **GeR**

line 1 ➔
line 2 ➔

```
GeR  AUGUGUUUGCCGUGUGAU
     STACysLeuProCysAsp
```

Starting these menus a nucleotide sequence can also be displayed by a memory function. See ch. 9, p. 78.

Input: Press the keys below the symbols for the bases (A, T / U, G, C). (In line 2 appears the corresponding amino acid sequence.)

The input of nucleotide sequences (or calling them up from memory) can only be performed in **GeD** und **GeR** (see ch. 8.2). Data delivered from memory functions can be replaced by new inputs!

The input of a nucleotide sequence will be taken over into the menus **Ge1** up to **Ge5**. There they serve as the base for further calculations. (**Ge6** is a lexical function: base tripletts that code a special amino acid.)

d) **Calculator mode** (constants, atomic mass unit):

- In line 1 the letters: "**Calculator**" appear.
- This is also the case with the functions „**C**" ("**2nd**" and "**5**") and "**u**" ("**2nd**" and "**6**"). Called up values can be used in the calculator mode.
- By pressing any operation key, it is possible to get into the calculator mode. Then the letters "**Calculator**" appear.

3.1.2 Line 2

a) **Left Side:** Before the sign " **=** " you find a formula sign for the value displayed or required.

Line 1 ➔
Line 2 ➔

```
Sol n/V[mol/l] → m[g]
[x] = 0 mol/l
```

Exceptions:
Menus **GeD**, **GeR**, **P3**, **P4 Lib**, **Ge6**.

Examples (a signalling zero is marked by underlining):

- "**M** = 98.0734 g/mol" (**molar mass** = 98.0734 g / mol)
- "**[x]** = 0 mol/l" (**value x of moles per l** = ... mol / l)
- "**V** = 0 l" (**Volume** = ... liter) / "**OD** = 0 " (**optical density** = ...)

Explanation of further abbreviations: see ch. 11.1.

P1 – P2: There is an element symbol on the display's left side without " = ".

b) **Right side of line 2**

b1) **Corresponding values** appear in line 2 after an input in line 1 or if data are delivered by a memory function.
(see page 11, ch. 3.1.1 c):

Line 1 ➔
Line 2 ➔

```
M1  H2SO4
M = 98.0734 g/mol
```

Molar masses after input of compound formulas in the menus **M1**–**M4**, **Sol**, **C1**–**C3**, **P1**–**P4**.

```
GeR  AUGUGUUUGCCGUGUGAU
     STACysLeuProCysAsp
```

Amino acid sequences after input of nucleotide sequences in the menus **GeD** and **GeR**.

b2) **An input is required** (at the beginning or in the course of a menu)

- ***Zero is signalling:***

Line 1 ➔
Line 2 ➔

```
Sol n/V[mol/l] → m[g]
[x] = 0 mol/l
```

Zero has to be written over by a number. In Menu **M1** zero signals in line 2 at the menu start (see ch. 3.1.1). The input, however, is displayed in line 1. In line 2 corresponding values appear [see example under b1) on this page or chapter 5.2 with more details].

- ***A proposed value is signalling:***

Line 1 ➔ `C3 K[%],ρ → x[mol/l]`
Line 2 ➔ **ρ = 910 g/l**

← signalling is symbolized by underlining

Example: In menu **C3** (conversion: mass percentage into mol / l) the density of some acids / bases for commonly available concentrations is proposed (memorized values see page 37). The signalling value can be replaced or affirmed by pressing the key " **=** ".

Example in the display above: NH_3 aq [aqueous solution of ammonia] with a mass percentage of 25: density ρ = 910 g / l.)

c) **A result is indicated**

After pressing the key " **=** " results are indicated on the right side of line 2. This value never signals!

Line 1 ➔ `P1 H2SO4`
Line 2 ➔ **S 32.6898 %**

In line 2 of this example the percentage of the element Sulfur (S) in the compound H_2SO_4 is indicated.

d) **Calculator mode** (line 1: "**Calculator**")

Inputs and the display of results are performed in line 2 (see ch. 2.1). When you call up a constant in function "**C**" (press "**2nd**" and "**5**") or the atomic mass unit in function "**u**" (press "**2nd**" and "**6**") the value and its unit appear in line 2 (see ch. 6.1 and 6.2).

Calculator
N_A = 6.02252e+23 mol^{-1}

Abbreviation before " **=** ": Symbol of a constant (here N_A) or "u" for the atomic mass unit.

e) **Exactness of input / indication of results in line 2**

There are six digits disposable for the input / display of numbers in line 2 (up to seven digits for values x, for which is valid: **-1 < x < 1**).

For numbers with absolute values (magnitudes) **>** | **999 999** | or **<** | **0,000 001** | the input or the indication of results is performed by expressing these numbers as powers of 10 (from $\mathbf{10^{-37}}$ up to $\mathbf{10^{+37}}$). The input of such values is done with the function "**exp**" (see ch. 8.2).

3.1.3 Top Line

Top line ➔

The left side of the top line contains the following symbols:

⬅ ***Arrow to the left*** (alone or with another arrow on the right side):
If this sign appears, it is possible to scroll the display to the left: The data input reaches beyond the left side of the display (see ch. 3.3).

RM ***Symbol "Read Memory"*** : It appears, if the keys

- "**RM**" (Read Memory; calling up data from a memory place) oder
- "**2nd**" and "**RM**"(second function of "**M**" [memory] is activated)

are pressed (memory functions: see ch. 9).

2nd ***Symbol "Second Function"*** : It appears, if the key "**2nd**" has been pressed and the second functions are activated (see ch. 1.3).

The right side of the top line contains the following symbols:

▭ ***Battery symbol*** : not active in this version (see. ch. 10.1).

➔ ***Arrow to the right*** (alone or with another arrow on the left side):
If this sign appears, it is possible to scroll the display to the right: The data input reaches beyond the right side of the display (see ch. 3.3).

3.2 DELETING

3.2.1 Key "clr" (clear)

a) Stoichiometric Functions

a1) ***Correction of Compound Formulas***

In the menus **M1**, **Sol**, **C1–C3**, **P1–P2** a compound formula can be corrected during the data input.
I.e. before pressing the key " **=** ". Afterwards the element symbols and subscripts put in are treated as a compound formula and get processed).

Pressing the key "**clr**" deletes the last part of a compound formula during the input:

- the complete subscript (stoichiometric number) or
- all letters of an element symbol.

Remarks: Pressing an element key in the calculator mode or in the menus **M2**–**M4** causes the device to chance automatically to menu **M1**. The input of compound formulas is not possible in the menus: **T**, **D** und **F**.

a2) ***Deleting whole compound formulas and molar masses***

There are two ways of deleting the complete and processed input of a compound formula (i.e. after pressing the key " **=** "):

- **Press key** "**clr**" (only possible in menu **M1**).
  The molar mass (indicated in line 2) is deleted together with the compound formula (indicated in line 1).
- **Write a new formula over the old one** and press key " **=** ".
  Afterwards this new compound formula will be the base for further calculations in all stoichiometric menus.

  Deleting a whole compound formula with the key "**clr**" is only possible in menu **M1,** but not in the menus **Sol**, **C1**–**C3**, **P1**–**P2**.
  Instead of changing to menu **M1** from these menus it is advisable to directly replace the compound fomula.

Deleting a whole input is also possible concerning:

- Compound formulas called up from a memory space (see. ch. 9).
- The input of molar masses in line 2 without the input of a compound formula in line 1 (compound formula unknown; see ch. 5.2, 3c).
  This kind of input is only possible in menu **M1**.

a3) ***Deleting the input of numbers***

After the input of a number in the menus:
M2–**M4**, **Sol**, **C1**–**C3**, **T**, **D**, **F**, **P2**, **P4**:

all digits of this number are deleted by pressing the key "**clr**".

In the menu group **P** this function is only activated in menu **P2** and **P4** for the input of a substance's amount in "**g**". Other values are indicated automatically.

b) **Menus for Molecular Biology**

b1) ***Menus* GeD / GeR *(input of oligonucleotides)***

Pressing this key deletes

- during the input of a sequence: the last nucleotide put in (line 1). After deleting the third nucleotide of a codon the three-letter-code of the corresponding amino acid (line 2) is deleted too.
- the whole oligonucleotide after input and processing, i.e. after pressing the key " **=** " (see ch. 5.18 and 5.19).
- the whole oligonucleotide called up by a memory function (see ch. 9).

The input of oligonucleotides in **GeD** / **GeR** (or oligonucleotides called up by a memory function) are taken over automatically into the menus **Ge1**–**Ge5**. In these menus it is not possible to delete them by pressing the key "**clr**". For this you must change to menu **GeD** / **GeR**.

b2) ***Submenus* Ge2**–**Ge5** (*of* **GeD** *and* **GeR**):

After the input of a number pressing this key deletes

- all digits of this number.

***Submenus* G1** *and* **G6**: The key "**clr**" is not active / needed.

c) **Calculator mode**

After the input of a number pressing this key deletes

- all digits of this number.

d) **Other remarks concerning the key "clr"**

Deleting a whole compound formula or oligonucleotide with the key "**clr**" removes these inputs also from the automatic memory function. After switching off the device respectively pressing the key "**on**" during use these inputs are lost (see. Kap. 9.1).

In some menus (e.g. **Lib**) or functions (e.g. Call-up of constants, see ch. 6.1) this key is not active.

3.2.2 Key “on“ (master -clear-key)

Pressing the key “**on**“ in any menu causes the device to set back to the calculator mode (see ch. 2.1). In line 2 zero is signalling.

```
Calculator
0
```

← signalling is symbolized by underlining

The last input made in a menu (i.e. compound formulas in stoichiometric menus and oligonucleotides in menus for molecular biology) are always memorized automatically. They are displayed again when entering a menu.
This is also the case, if the device has been turned off in the meanwhile or if the key “**on**“ has been pressed during use.

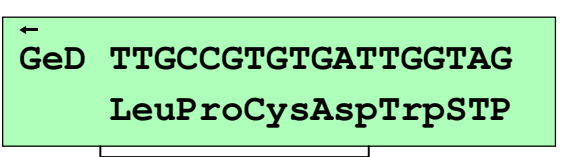
3.3 SCROLLING THE DISPLAY

Inputs made in a menu, i.e.

- Compound formulas in the stoichiometric functions,
- Oligonucleotides menus for molecular biology,

may also reach beyond the left or right frame of the display.
Arrows at the left or the right side of the display’s top line indicate, that this is the case:

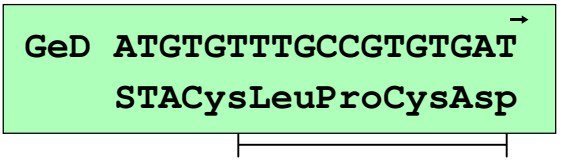
***Arrow to the left*:** The input reaches beyond the display‘s left frame.



By pressing this key (“**Scroll left**“) the legible part of the whole input is moved for one unit of the input (one nucleotide, symbol of an element or digit of a subscript [stoichiometric number]) to the left.
(The underlined part is also visible in the next illustration).

Example: Starting with the last display picture (page before) you get the following display after having six times pressed the key "**Scroll left**" (The display moves for six nucleotides to the left):

***Arrow to the right*:** The input reaches beyond the display's right frame:

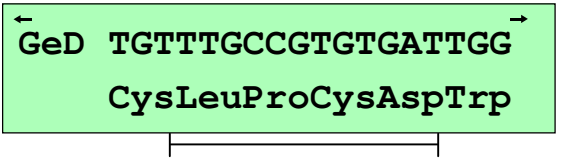


The underlined part of the nucleotide sequence markes the part, that was also visible in the last display.

By pressing this key ("**Scroll right**") the legible part of the whole input is moved for one unit of the input (one nucleotide, symbol of an element or digit of a subscript [stoichiometric number]) to the right.

Example: Starting with the last display picture (page before) you get the following display after having three times pressed the key "**Scroll right**" (The display moves for three nucleotides to the left):

***Arrows at the left and right frame of the top line*:**
The input reaches on both sides beyond the frame of the display:



The underlined part of the nucleotide sequence markes the part, that was also visible in the last display.

Analogous to the explanations above scrolling to the left or to the right is possible now.

4 SHORT INSTRUCTIONS FOR MENU CONTROL

Preliminaries: It is advisable to study ch. 1–3 before using this device for the first time. Afterwards these short instructions can serve as recollecting aid for the main points of operation (see backcover of the manual). The single menus are self-explanatory to a high degree. Details and variations of menu control, especially within the menus and further informations (e.g. formulas used) are delivered in chapter 5.

a) 

Press "**on**": The device is in the calculator mode (**`Calculator`**).

b) 

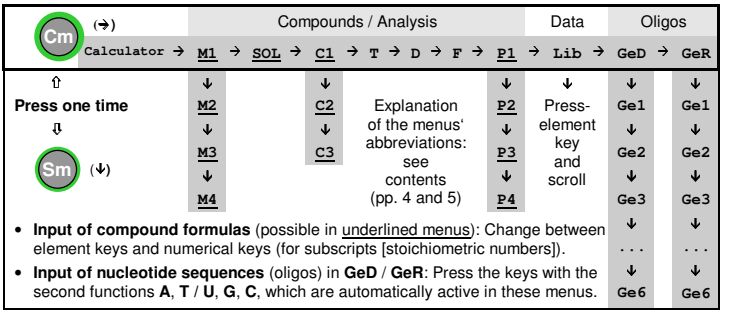
Press "**Cm**" or an element key (e.g. 

): Change to menu **`M1`**.

c) Press "**Cm**" for entering the following menus / menu groups.

d) 

"**Sm**": If there is a number behind a menu's abbreviation (or in **`GeD`** / **`GeR`**) submenus of this menu group are entered with the key "**Sm**":



e) 

Key " **=** ": Moving forward within a menu (new input, indicating a result).

f) 

"**clr**"**: 1) Correcting** inputs (elements, subscripts, nucleotides, numbers). **2) Deleting** whole compound formulas/oligonucleotides, that have been put in completely (or called up by a memory function) and are processed.

g) 

Scrolling: 1) If inputs reach beyond the display's frame (an arrow appears on the left or/and the right side of the display's top line), it is possible to scroll left or right by pressing these keys. **2)** Navigating through **`Lib`** / **`Ge6`**.

5 **MENU DESCRIPTIONS** – DETAILED INSTRUCTIONS

5.1 PRELIMINARIES

a) **The order of descriptions** corresponds to the order of menus pressing the keys "**Cm**" and "**Sm**" (see graphic on p. 20 a. ch. 2.2 a. ch. 2.3).

If a menu consists out of a group of several submenus, all submenus are dealed with in the order, in which these submenus are entered by pressing the key "**Sm**".

All steps within a calculation are described in tables. Alternatives for the input of data are also listed.

b) **At the end of a menu's / submenu's** description there are additional remarks and explanations for understanding how the menu is operating:

- Values and formulas, that are used by the device for operations;
- Possibilities of further processing with displayed results;
- Other comments.

c) **Symbolizing signalling values (underlining):**

- If inputs are required in the display: Zero signals.
- If values are proposed (e.g. in menu C3 for densities): The value signals.

In graphics signalling numbers are symbolized by underlining!

d) **Automatic memory function:** The last inputs, i.e.

- **compound formulas** in stoichiometric menus (input possible in **M1**, **Sol**, **C1**–**C3**, **P1**–**P2**) and
- **nucleotide sequences** in the menus **GeD** und **GeR**,

are automatically memorized. They are displayed when a menu is entered again and serve as base for further calculations.

This is not the case, if the last compound formula/nucleotide sequence put in has been deleted with the key "**clr**" before

- turning off the calculator or
- pressing the key "**on**" during use (master-clear-key).

5.2 M1 MOLAR MASS OF A SUBSTANCE

Display	Keys	Actions / Comments

Enter Menu M1

1a	Any display		Press (repeatedly) "**Cm**" (Change to the next menu) until menu **M1** appears **Continue with 2a or 2b**
Alternatives:			
1b	Any display		Press "**2nd**" and "**Cm**" until menu **M1** appears. The menus are entered in the opposite order. **Continue with 2a or 2b**

1c	Calculator mode
	`Calculator`
	`0`
		e.g.:
		 
			Press an element key, e.g. "**C** ^{6}"
			Continue with 3a

Display 2a or 2b appears

2a	`M1 Molar Mass` `M = 0 g/mol`	**Zero is signalling.** The last compound formula has been deleted with "**clr**"; see. ch. 9.1. **Continue with 3a, 3b or 3c**
2b	`M1 NH3` `M = 17.0304 g/mol`	**The last compound formula input appears** (automatic memory call-up; see. ch. 8.1) – example here: **NH_3**. • If you want to continue with the automatically called-up compound formula: - **Take it over and don't change it.** - **Continue with the keys "Cm" oder "Sm" for entering other menus** . • If you want to continue with another compound formula: - **Replace it by writing over the old formula.** - **Continue with step 3a**

Alternative of continuation 1: Input of a compound formula

3a	M1 C_6 M = 12.011 g/mol Compound formulas with brackets / maximum length of an input: see remarks at the end of this chapter.	C 6 6 ...	Press **element keys** (e.g. "**C**..^{6}.") and **numerical keys** (z.B. "**6**") ... Example here: input of $C_6H_{12}O_6$
4	M1 $C_6H_{12}O_6$ M = 15.9994 g/mol	=	Press " **=** " (after the complete input)
5	M1 $C_6H_{12}O_6$ M = 180.157 g/mol		**Line 1: Compound formula** **Line 2: Molar mass**

Alternative of continuation 2: Call-up of a compound formula

3b	RM M1 Molar Mass M = g/mol M1 H_2SO_4 M = 98.0734 g/mol	RM e.g.: 2	Press key "**RM**" ("RM" appears in the display's top line) Press numerical key ("**0**" – "**9**") for memory space. ("RM" vanishes from the display's top line) **Line 1: Compound formula** **Line 2: Molar mass**

Alternative of continuation 3: Input of a molar mass without a compound formula

3c	M1 Molar Mass M = 45.3 g/mol	4 5 . 3	Input of any molar mass: e.g. "**45.3**" g / mol (only numerical keys!) This input can be processed in other menus.

Remarks

Step 3c

- This possibility of input serves for calculations with substances, whose molar mass is known, but not the parts respectively the percentage of the parts.

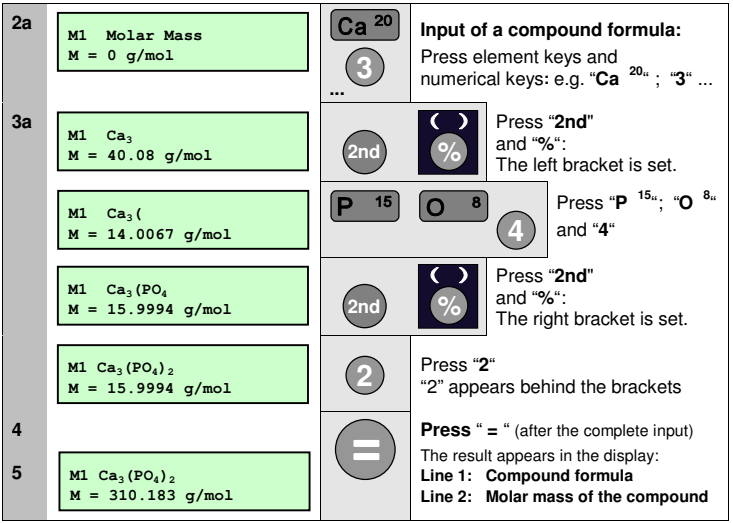
Step 3a

- After each pressing of an element key appears the molar mass of the represented element in line 2 of the display. This value does not change after the input of a subscript (stoichiometric number) greater than "1". No provisional results are indicated in line 2. Only after pressing the key " = " (**4**) the molar mass of the whole compound is indicated (**5**).
- The molar masses of elements displayed are average values of the naturally occuring elements (natural isotope mixtures). Molar masses of isotopes cannot be called up.

Bracket Function

The brackets (second function of the key "**%**") can be used for the input of compound formulas with brackets (only for one level of brackets, input of interlocked brackets is not possible).

Example: **$Ca_3(PO_4)_2$** (Calciumphosphate):



The bracket function is not disposable in the calculator mode. It can only be used for the input of compound formulas in the stoichiometric menus.

Maximum Length for the Input of Compounds

The input of compounds may constist of a maximum of 20 elements and their subscripts (stoichiometric numbers). If the compound formula reaches beyond the length of the display, it is possible to scroll (scroll function: see page 18 ch. 3.3).

Continuation with Results in Other Menus / in the Calculator Mode

- The compound formula (**5** / **3b**) respectively the input of a molar mass (**3c**) are automatically taken over into other stoichiometric menus (**M2**–**M4, Sol**, **C1**–**C3**, **P1**–**P4**). There these data are used as the base for further calculations.
- In these menus the data taken over can be replaced by writing over with a new compound formula (input as described in **3a** – **5**).
  Inputs according to step **3c** (molar mass without compound formula) cannot be replaced in other stoichiometric menus. Only the input of a compound formula is possible there. For the input of a molar mass according to step **3c** you must again enter menu **M1**. Then the new value can be taken over again into other menus.
- It is possible to perform further calculations with a result (**5**) in the calculator mode. After pressing an operation key in the right part of the keyboard (e.g. pressing the key " **×** ") the device changes automatically into the calculator mode.

Symbolizing of Signalling Numbers (Underlining):

A zero is signalling, if the input of numbers is required. In the illustrations signalling of a number is marked by underlining: "**0**".

Automatic Memory Function

The last input of a compound formula is automatically memorized. It is again disposable when entering a stoichiometric menu and serves as base for further calculations. This is not the case, if the last input of a compound formula has been deleted with the key "**clr**" before turning off the device or pressing the key "**on**" (master-clear-key) during use.

5.3 M2 CONVERTING A SUBSTANCE'S AMOUNT: mol into g

	Display	Keys	Actions / Comments
1	Any display	Cm	Press (repeatedly) "**Cm**" (Change to the next menu) until menu **M1** appears

Continue with menu M1: Take over or put in a compound formula (molar mass)

2	M1 $C_6H_{12}O_6$ M = 180.157 g/mol		Example here: Display of the last input of a compound formula (see p. 22, menu **M1**, **2b**)
Alternatively a zero might signal in line 2 (see p. 22, menu **M1**, **2a**). Input respectively take-over or change of compound formulas / molar masses: see p. 22 f. menü **M1**, **3a** – **3c**.			

Continue with menu M2

3		Sm	Press "**Sm**": Submenu **M2** appears
	M2 n[mol] → m[g] n = 0 mol		Line 1: Explanation **Line 2: Zero is signalling.**
4	M2 n[mol] → m[g] n = 1.7 mol	1 . 7	Input: **Amount in mol**: e.g.: "**1,7**" mol (Numerical keyboard)
5	M2 $C_6H_{12}O_6$ m = 306.267 g	=	Press " **=** " **Result:** **Line 1: Compound** **Line 2: The substance's amount in g**

Remarks

1) It is possible to perform further calculations with a result (**5**) in the calculator mode.
2) The result can be memorized if needed (see ch. 8.2).

5.4 M3 CONVERTING A SUBSTANCE'S AMOUNT: g into mol

	Display	Keys	Actions / Comments
1	Any display	Cm	Press (repeatedly) "**Cm**" (change to the next menu) until menu **M1** appears

Continuation with menu M1: Take-over or input of a compound formula (molar mass)

2	M1 $C_6H_{12}O_6$ M = 180.157 g/mol	Example here: Display of the last input of a compound formula (see p. 22, menu **M1**, **2b**)
Alternatively a zero might signal in line 2 (see p. 22, menu **M1**, **2a**). Input respectively take-over or change of compound formulas / molar masses: see p. 22 f. menü **M1**, **3a** – **3c**.		

Continue with menu M3

3	M3 m[g] → n[mol] n = 0 mol	Sm	Press "**Sm**" two times Submenu **M3** appears Line 1: Explanation **Line 2: Zero is signalling.**
4	M3 m[g] → n[mol] n = 306 g	3 0 6	Input: **Amount in g**: e.g.: "**306**" g (numerical keyboard)
5	M3 $C_6H_{12}O_6$ M = 1.69852 mol	=	Press " **=** " **Result:** **Line 1: Compound** **Line 2: Substance's amount in mol**

Remarks

1) It is possible to perform further calculations with a result (**5**) in the calculator mode.
2) The result can be memorized if needed (see ch. 8.2).

5.5 M4 IDEAL GAS VOLUME OF A SUBSTANCE

	Display	Keys	Actions / Comments
1	Any display	Cm	Press (repeatedly) "**Cm**" (Change to the next menu) until menu **M1** appears

Continue with menu M1: Take-over or input of a compound formula (molar mass)

2	M1 $C_6H_{12}O_6$ M = 180.157 g/mol	Example here: Display of the last input of a compound formula (see p. 22, menu **M1**, **2b**)
Alternatively a zero might signal in line 2 (see p. 22, menu **M1**, **2a**). Input respectively take-over or change of compound formulas / molar masses: see p. 22 f. menu **M1**, **3a** – **3c**.		

Input of the substance's amount in submenu M2 or M3

3		Sm	Press "**Sm** " once or twice Change to submenü **M2** or **M3**
4 – 5	Now you have to put in the substance's amount in menu **M2** (in moles) or **M3** (in grammes) as described in ch. 5.3 or 5.4 (step **4** – **5**). See p. 26 or 27.		

6	**Result:** M4 n[mol] → V[l] V = 44.8 l e.g. input of "$C_6H_{12}O_6$" in **M1** and of "360,314" g in **M3**	Sm	Press "**Sm**" (1 x or 2 x) Change to submenu **M4** Line 1: Explanation **Line 2: Ideal gas volume** of the substance according to the input in step **4** - **5**

Remarks

1) It is possible to perform further calculations with a result (**6**) in the calculator mode.
2) The result can be memorized if needed (see ch. 8.2).
3) Formula: $V_m = n$ mol • V_{mol} – standard conditions presupposed;
   Ideal gas volume of the substance X (in: l) = amount of X (in: mol) • mole volume (≈ 22,4 l / mol)

5.6 Sol SOLUTION: Mass of a solute in g

	Display	Keys	Actions / Comments
1	Any display	Cm	Press (repeatedly) "**Cm**" (change to the next menu) until menu **SOL** appears

Continue with menu Sol (The display indicates **2a** or **2b**)

2a	Sol Solution M = 0 g/mol		**Line 1:** Abbreviation and name of the menu **Line 2:** **0 g** / **mol**; the last input of a compound formula / molar mass has been deleted with "**clr**" – **Continue with step 3b**
2b	Sol Solution M = 180.157 g/mol e.g. molar mass of $C_6H_{12}O_6$		**Line 1:** Abbreviation and name of the menu **Line 2:** **Molar mass** of the last input (substance) **Continue with 3a**

Continuation: 4 alternatives (**3a** – **3d**)

3a	**Take-over of a compound formula** / **molar mass** for further calculations	=	**Press** " **=** " **Continue with 4**
3b	**Input of a new compound formula** (like in menu **M1**: ch. 5.2:, step **3a** – **5**)		
	Sol H_2 M = 1.0079 g/mol e.g. input of H_2SO_4	H 1 2 ...	Press **element keys** (e.g. "**H** ^{1}") and **numerical keys** (e.g. "**2**")
	Sol Solution M = 98.0734 g/mol e.g. H_2SO_4: M = 98,0734 g / mol	=	**Press** " **=** " (after complete input) A new display appears: Line 1: Menu abbreviation and name **Line 2: Molar mass** **Continue with 3a**
3c	**Calling up a compound formula (see ch. 5.2 3b and 9.2.3) – Continue with 3a**		

3d **Input of molar mass without compound formula:** Only possible in menu **M1** (see ch. 5.2, **3c**). Enter menu **Sol** again with key "**Cm**" – **continue with step 3a**.

Input of the solute's concentration in moles per volume

4

```
Sol n/V[mol/l] → m[g]
[x] = 0 mol/l
```

e.g. H_2SO_4 like in step **3b**

```
Sol n/V[mol/l] → m[g]
[x] = 1.5 mol/l
```

Line 1: Explanation
Line 2: Zero is signalling:
Input of a value for the concentration of the solute, e.g. "**1,5**"

Press " = ":
A new display appears (**5**).

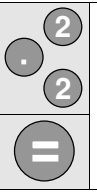
Input of the solution's volume

5

```
Sol n/V[mol/l] → m[g]
V = 0 l
```

e.g. H_2SO_4 like in step **3b**

```
Sol n/V[mol/l] → m[g]
V = 2.2 l
```



Line 1: Explanation
Line 2: Zero is signalling:
Input of a value for the solution's volume, e.g. "**1,5**"

Press " = ":
The result is displayed (**6**).

Result: The solute's mass

6

```
Sol H2SO4
m = 323.642 g
```

Line 1: Compound formula
Zeile 2: Mass of the solute in grammes

e.g. H_2SO_4 like in step **3b**

If there has been only the input of a molar mass without compound formula in menu **M1**, the left side of line 1 remains empty (see ch. 5.2, **3c**).

Remarks

1) It is possible to perform further calculations with a result (**6**) in the calculator mode.
2) The result can be memorized if needed (see ch. 8.2).
3) Formula: $m = M_x \bullet c_x \times V$

needed mass (in: g) of a substance X (solute) **=**
molar mass of X (in: g / mol) • concentration of X (in: mol / l) × volume of solution (in: l)

5.7 C1 CONCENTRATION – CONVERSION:

Mass concentration (g / l) into moles per volume (mol / l)

	Display	Keys	Actions / Comments
1	Any display	Cm	Press (repeatedly) "**Cm**" (change to the next menu) until menu **C1** appears.

Continue with menu C1 (the display indicates **2a** or **2b**)

2a	`C1 Concentration` `M = 0 g/mol`		Line 1: Abbreviation and name of the menu **Line 2:** **0 g** / **mol**; the last input of a compound formula / molar mass has been deleted with **"clr" - Continue with step 3b**

2b	`C1 Concentration`
	`M = 180.157 g/mol`
	e.g. molar mass of $C_6H_{12}O_6$
			Line 1: Abbreviation and name of the menu
			Line 2: **Molar mass** of the last substance put in
			Continue with 3a

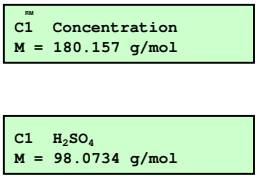
Continuation: 4 alternatives (**3a** – **3d**)

3a	**Take-over of a compound formula** / **molar mass** for further calculations	=	**Press** " **=** " **Continue with 4**
3b	**Input of a new compound formula** (like in menu **M1**: ch. 5.2:, step **3a** – **5**)		

	`C1 H2`
	`M = 1.0079 g/mol`
	e.g. input of H_2SO_4
		H 1
		2
		...
			Press **element keys** (e.g. "**H** [1]")
			and **numerical keys** (e.g. "**2**")

	`C1 Concentration`
	`M = 98.0734 g/mol`
	e.g. H_2SO_4: M = 98,0734 g / mol
		=	**Press** " **=** " (after complete input)
			A new display appears:
			Line 1: Menu abbreviation and name
			Line 2: Molar mass
			Continue with 3a

3c **Call-up of a compound formula from a memory space**



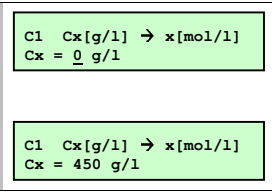
Press "**RM**"
"RM" appears in the display's top line.
Press numerical key ("**0**" – "**9**") for memory space.
"RM" vanishes from the display's top line.

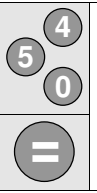
Line 1: **Compound formula**
Line 2: **Molar mass**

3d **Input of a molar mass without compound formula:** Only possible in menu **M1** (see ch. 5.2, **3c**). Enter menu **C1** again with key "**Cm**" – **Continue with step 3a**

Input: Mass concentration

4



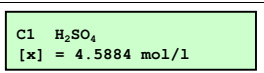


Line 1: **Explanation**
Line 2: **Zero is signalling:**
Input: value for the mass concentration, e.g. "**450**" g

Press " = ":
The result appears (**5**).

Result: Concentration in moles per volume

5



Line 1: **Compound formula (or 5a)**
Line 2: **Concentration in mol / l** (molarity)

5a If there has been only the input of a molar mass without compound formula in menu **M1**, the left side of line 1 remains empty (see ch. 5.2, **3c**).

Remarks

1) It is possible to perform further calculations with a result (**5**) in the calculator mode.
3) The result can be memorized if needed (see ch. 8.2).
4) Formula: $[x] = c_x \ / \ M_x$

   Concentration in moles per volume (molarity) of a substance X (in: mol / l) **=**
   mass concentration of X (in: g / l) / molar mass of X (in: g / mol)

5.8 C2 CONCENTRATION – CONVERSION:

Moles per volume (mol / l) into mass concentration (g / l)

	Display	Keys	Actions / Comments
	Enter menu C2		
1	Any display		Press (repeatedly) "**Cm**" (change to the next menu) until menu **C1** appears.
	`C1 Concentration` `M = 0 g/mol`		Line 1: Menu abbreviation and name **Line 2: Here „0 g / mol"** (see **3a**) A value for a molar mass could also be indicated (see **3b**).
2			Press "**Sm**" (1 ×): Submenu **C2** appears
	Continue with menu C2 (The display indicates **3a** oder **3b**)		
3a	`C2 Concentration` `M = 0 g/mol`		Line 1: Menu abbreviation and name **Line 2: 0 g / mol**; the last input of a compound formula / molar mass has been deleted with **"clr"** **Continue with 4b**

3b	`C2 Concentration`
	`M = 180.157 g/mol`
	Example here: molar mass of $C_6H_{12}O_6$
			Line 1: Menu abbreviation and name
			Line 2: Molar mass of the input
			Continue with 4a

	Continuation: 4 alternatives (**4a** – **4d**)		
4a	**Take-over of compound formula / molar mass** for further calculations		**Press " = "** **Continue with 5**
4b	**Calling up a compound formula (see ch. 5.2 3b and 9.2.3) – Continue with 4a**		

4c **Input of a compound formula** (like in menu **M1**: ch. 5.2:, step **3a** – **5**)

```
C2 H2
M = 1.0079 g/mol
```

e.g. input of H_2SO_4

Press **element keys** (e.g. "**H** **1**")

and **numerical keys** (e.g. "**2**")

Press " **=** " (after complete input)

A new display appears:

Line 1: Menu abbreviation and name

Line 2: Molar mass

```
C2  Concentration
M = 98.0734 g/mol
```

e.g. H_2SO_4: M = 98,0734 g / mol.

Continue with 4a

4d **Input of a molar mass without compound formula:** Only possible in menu **M1** (see ch. 5.2, **3c**). Enter menu **C1** again with key "**Cm**", then menu **C2** with key "**Sm**".
Continue with 4a

Input: Concentration in moles per volume

5

```
C2 x[mol/l] → Cx[g/l]
[x] = 0 mol/l
```

Line 1: Explanation

Line 2: Zero is signalling:

Input of a value for the concentration in moles per volume, e.g. "**4,5**"

```
C2 x[mol/l] → Cx[g/l]
[x] = 4.5 mol/l
```

Press " **=** ":

The result appears (**6**).

Result: Mass concentration (example here: H_2SO_4)

6

```
C2  H2SO4
Cx = 441.33 g/l
```

Line 1: Compound formula (or 6a)

Line 2: Mass concentration

6a If there has been only the input of a molar mass without compound formula in menu **M1**, the left side of line 1 remains empty (see ch. 5.2, **3c**).

Remarks

1) It is possible to perform further calculations with a result (**6**) in the calculator mode.
2) The result can be memorized if needed (see ch. 8.2).
3) Formula: $c_X = M_X \bullet [x]$
   mass concentration of substance X (in: g / l) **=**
   molar mass of X (in: g / mol) • concentration in moles per volume (molarity) of X (in: mol / l)

5.9 C3 CONCENTRATION – CONVERSION: mass percentage into moles per volume (mol / l)

Display	Keys	Actions / Comments

Enter menu C3

1	Any display		Press (repeatedly) "**Cm**" (change to the next menu) until menu **C1** appears.
	`C1 Concentration` `M = 0 g/mol`		Line 1: Menu abbreviation and name **Line 2: Here: "0 g / mol"** (see **3a**); a value for a molar mass could also be indicated (see **3b**).
2			Press "**Sm**" (2 ×): Submenu **C3** appears

Continue with menu C3 (the display indicates **3a** or **3b**)

3a	`C3 Concentration` `M = 0 g/mol`		Line 1: Menu abbreviation and name **Line 2: 0 g / mol**; the last input of a compound formula / molar mass has been deleted with **"clr"**. **Continue with 4b**

3b	`C3 Concentration`
	`M = 180.157 g/mol`
	Example here: molar mass of $C_6H_{12}O_6$
			Line 1: Menu abbreviation and name
			Line 2: Molar mass of the last input
			Continue with 4a

Continuation: 4 Alternatives (**4a** – **4d**)

4a	**Take-over of compound formula / molar mass** for further calculations		**Press " = "** **Continue with 5**
4b	**Call up of a compound formula** (ch. 5.2 3b and 9.2.3) – **Continue with 4a**		

4c **Input of a new compound formula** (like in menu **M1**: ch. 5.2:, step **3a** – **5**)

```
C3 H2
M = 1.0079 g/mol
```

e.g. input of H_2SO_4

H 1

2

...

=

Press **element keys** (e.g. "**H** [1]")

and **numerical keys** (e.g. "**2**")

Press " = " (after complete input)

A new display appears:
Line 1: Menu abbreviation and name
Line 2: Molar mass

Continue with 4a

```
C3  Concentration
M = 98.0734 g/mol
```

e.g. H_2SO_4: M = 98,0734 g / mol

4d **Input of a molar mass without compound formula:** Only possible in menu **M1** (see ch. 5.2, **3c**). Enter menu **C1** again with key "**Cm**", then menu **C3** with key "**Sm**".
Continue with 4a

Input: Mass percentage (see remarks for volume percentage)

5

```
C3  K[%],ρ → [mol/l]
K = 0 %
```

2

5

Line 1: Explanation
Line 2: Zero is signalling:
Input of a value for the ma percentage, e.g. "**25**" %

```
C3  K[%],ρ → [mol/l]
K = 25 %
```

=

Press " = ":
A new display appears (6a o. 6b)

Input of density: Display **6a** or **6b** appears

6a

```
C3  K[%],ρ → [mol/l]
ρ = 0 g/l
```

1 8 4 0

Line 1: Explanation
Line 2: Zero is signalling:
Input of a value for the density, e.g. "**1840**" g / l

6b

```
C3  K[%],ρ → [mol/l]
ρ = 910 g/l
```

Example here: value for NH_3

New input with numerical keys if needed.

Line 1: Explanation
Line 2: A proposed value is signalling:
Take it over (**7**) or **replace it**
(see remark 3 below)

7

```
C3  K[%],ρ → [mol/l]
ρ = 1840 g/l
```

=

Press " = ":
A new display appears (**8**).

Result: Concentration in moles per volume

8	C3 H_2SO_4 [x] = 4.69036 mol/l	Line 1: Compound formula (or **8a**) **Line 2: Concentration in mol / l**
8a	If there has been only the input of a molar mass without compound formula in menu **M1**, the left side of line 1 remains empty (see ch. 5.2, **3c**).	

Remarks

1) It is possible to perform further calculations with a result (**8**) in the calculator mode.
2) The result can be memorized if needed (see ch. 8.2).
3) Densities are proposed for the following acids, bases and solutions (**6b**), that are listed in commonly available concentrations:

Name	Compound formula	concentration in mol / l (rounded)	mass percentage	Density g / cm^3 20° / 4°
Sulphuric acid	**H_2SO_4**	36	95-97	**1,84**
Formic acid / H-COOH	**H_2CO_2**	26	98 - 100	**1,22**
Hydrobromic acid	**HBr**	7	40	**1,38**
Acetic acid / CH_3-COOH	**$H_4C_2O_2$**	18	99 - 100	**1,06**
Hydriodic acid	**HI**	7,5	57	**1,70**
Phosporic acid (concentrated)	**H_3PO_4**	15	85	**1,71**
Nitric acid (concentrated)	**HNO_3**	14	65	**1,40**
Hydrochloric acid (concentrated)	**HCl**	12	36	**1,18**
Ammonia (aqueous)	**NH_3**	13,5	25	**0,91**
Potassium hydroxide solution	**KOH**	7	30	**1,30**
Sodium hydroxide solution	**NaOH**	11	33	**1,36**

5) **Formula: $[x] = K \bullet \rho / M_X$**

Concentration in moles per volume (molarity) (in: mol / l) of a substance X **=**
mass percentage (here defined as „K“) • density of X (in: g / l) / molar mass of X (in: g / mol)

6) **Approximate calculation of volume percentage**

This is possible with the formula (4) above, if the density of a substance is known for a mass percentage of 100.

5.10 T TITRATION

Display	Keys	Actions / Comments

Enter Menu T

1	Any display
	`T Titration`
	`[x] = 0 mol/l`
		Cm	Press (repeatedly) "**Cm**"
			(change to the next menu)
			until menu **T** appears.
			
			Line 1: Menu abbreviation and name
			Line 2: "0 mol / l"; zero is signalling.

Input: Concentration in moles per volume

2	`T Titration` `[x] = 2.5 mol/l`	2 . 5 =	Input: Concentration of added solution: e.g. "**2,5**" mol / l (numerical keyboard) **Press " = ":** A new display appears (**3**)

Input: Volume

3	`T x[mol/l]/V[ml] → n`
	`V = 0 ml`
	
	`T x[mol/l]/V[ml] → n`
	`V = 55 ml`
		5 5
		=
			Line 1: Explanation
			Line 2: V = "0 ml"; zero is sig nalling.
			Input of the added solution's volume:
			e.g. "**55**" ml (numerical keyboard)
			
			Press " = ":
			The result appears (**4**).

Result: Amount of the added solution in mmol

4	`T x[mol/l]/V[ml] → n` `n = 137.5 mmol`		Line 1: Explanation **Line 2: Substance's amount in mmol** Example here: "**137,5 mmol**"

Remarks

1) It is possible to perform further calculations with a result (4) in the calculator mode.
2) The result can be memorized if needed (see ch. 8.2).
3) Formula: $n = [x] \bullet V$
   amount of the (added) substance X (in mmol) =
   concentration in moles per volume of X (in mol / l) • Volumen (in: ml)
4) Conversion of the substance's amount into grammes :
   - Convert result (4) into moles (• 1000) and
   - Multiplicate this result with the molar mass of the substance.

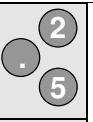
5.11 D DILUTION

Display	Keys	Actions / Comments

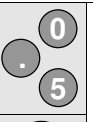
Enter Menu D

1	Any display
	`D Dilution`
	`[x]1 = 0 mol/1`
			Press (repeatedly) "**Cm**"
			(change to the next menu)
			until menu **D** appears.
			
			Line 1: Menu abbreviation and name
			Line 2: "0 mol / l"; zero is signalling.

Input: Concentration of the final solution

2	`D Dilution` `[x]1 = 2.5 mol/1`	 	Input: concentration of final solution: e.g. "**2,5**" mol / l (numerical keyboard) **Press " = ":** A new display appears (**3**)

Input: Volume of the final solution

3	`D [x]1,V1,[x]2 → V2`
	`V1 = 0 l`
	
	`D [x]1,V1,[x]2 → V2`
	`V1 = 0.5 l`
		
		 
			Line 1: Explanation
			Line 2: "V1 = 0 ml"; zero is signa lling.
			Input: Volume of final solution
			e.g. "**0,5**" l
			
			Press " = ":
			A new display appears (**4**)

Input: Concentration of the initial solution

4	`D [x]1,V1,[x]2 → V2` `[x]2 = 7.3 mol/l`	7 . 3 =	Input: Concentration of initial solution, e.g. "**7,3**" mol / l (numerical keyboard) **Press " = ":** The result appears (**5**).

Result: Initial volume in l

5	`D [x]1,V1,[x]2 → V2` `V2 = 0.171233 l`	Line 1: Explanation **Line 2: Volume of initial solution** Example here: "**0,171233 l**"

- You have to pipet 171 ml of an initial solution with a concentration of 7,3 mol / l.
- Fill this amount up with the solvens until a volume of 0,5 l is reached.
- Now you have a final solution with a concentration of 2,5 mol / l.

Remarks

1) It is possible to perform further calculations with a result (**5**) in the calculator mode.

2) The result can be memorized if needed (see ch. 8.2).

3) Formula: $V_2 = [x]_1 \bullet V_1 / [x]_2$

V_2 = volume to be pipetted (initial volume) of a substance X (in: l)
$[x]_1$ = desired concentration of X in the final solution (in: g / mol)
V_1 = desired volume of the final solution in which X is the solute (in: l)
$[x]_2$ = concentration of the initial solution with X as solute (g / mol)

5.12 F FORMULA – CALCULATING A COMPOUND FORMULA

Display	Keys	Actions / Comments

Prepare the necessary values

0 The following data have to be provided in order to be able to calculate the compound formula of a substance in this menu:

a) Mass percentage of the elements;

b) Molar mass of the substance and derived by it:

b1) The ideal gas volume of the substance at a specific ...

b2) ... mass of the compound (any mass could be chosen).

Provided that the substance's molar mass is known, it is possilbe to calculate the ideal gas volume corresponding to any mass in **M4**.

Procedure:

- Input of the molar mass in **M1**: Entering menu **M1** by pressing the key "**Cm**" (repeatedly) until menu **M1** appears. A compound formula possibly indicated automatically by the memory function has to be eliminated by pressing the button "**clr**". Now put in the molar mass with the numerical keys (see ch.5.2, step **3c**, page. 22).
- Change to subenu **M3** (press key "**Sm**" twice): put in any mass **(note down this mass)**; press key " **=** " (see ch. 5.4 on page 25).
- Change to submenu **M4** (press key "**Sm**" once): the ideal gas volume corresponding with the mass put in is indicated (see ch. 5.5 on S. 26).

Our examples: **a) C: 52 %; H: 13 %; O: 35 %**
b1) 4,86 l
b2) 10 g

Enter menu F

1 Any display

Press (repeatedly) "**Cm**"
(Change to the next menu)
until menu **F** appears.

```
F   Formula
V = 0 l
```

LIne 1: Menu abbreviation and name
LIne 2: "V = 0 l"; zero is signalling

Input: Ideal gas volume of the substance

2		4 . 8 6	Put in the ideal gas volume of the substance: e.g. "**4,86**" l (numerical keyboard)
	`F Formula` `V = 4.86 l`	=	**Press " = ":** A new display appears (**3**).

Input: Mass corresponding to the ideal gas volume

3	`F Formula` `m = 0 g`	1 0	Put in: mass corresponding to **2**: e.g. "**10**" g. (numerical keyboard)
	`F Formula` `m = 10 g`	=	**Press " = ":** A new display appears (**4**).

Input: First element and its percentage

4	`F Element 1:`	C 6	Press the key for the first element, e.g. "**C** ^{6}". (periodic system keyboard) A new display appears:
	`F Element 1: C` `m = 0 %`	5 2	Put in: mass percentage **%**: e.g. „"**52**" % (numerical keyboard)
	`F Element 1: C` `m = 52 %`	=	**Press " = ":** A new display appears (**5**).

Input: Second element and its percentage

5	`F Element 2:`	H 1	Press the key for the second element, e.g. "**H** [1]" (periodic system keyboard) A new display appears.
	`F Element 2: H` `m = 0 %`	1 3	Put in: mass percentage, e.g. "**13**" g (numerical keyboard)
	`F Element 2: H` `m = 13 %`	=	**Press " = ":** A new display appears (**6**).

Input: Third element and others

6	`F Element 3:`	Go on like in step **4** / **5**, e.g. with the keys "**O 8**", "**3**" and "**5**".

Result: Compound formula

7	`F Element 4:`	=	At first an appeal for putting in the next element: After input of all elements: **Press " = "**
	`F C2H6O` `M = 46.0688 g/mol`	Line 1: **Line 2:**	Abbrev. of menu / compound formula **Molar mass of the compound**

Remarks

1) The result can be memorized if needed (see ch. 8.2).
2) The order of the elements in the compound formula displayed depends upon the order of the elements during the input. The calculator does not arrange the elements according to the rules usually applied to formulas in chemistry. These rules should already be obeyed during the input.

3) Formula:

Starting with the relative atom masses of the substance's elements it is possible to calculate the molar mass of an unit X with entire stoichiometric numbers (Indices):

Element:	$m(\%)_{element}$	/	$M_{element}$	=	**relative number of atoms**	
Our example:						**Index**
C	$m(\%)_C$	/	M_C	=	relative number of atoms: C	4,33 / 2,18
	52 %	/	**12**	=	**4,33**	1,98 ≈ **2**
H	$m(\%)_H$	/	M_H	=	relative number of atoms: H	13 / 2,18
	13 %	/	**1**	=	**13**	5,96 ≈ **6**
O	$m(\%)_O$	/	M_O	=	relative number of atoms: O	2,18 / 2,18
	35 %	/	**16**	=	**2,18**	**1**

The lowest relative number of atoms 2,18 corresponds with the value 1 for an index. The indices of the other elements can now be calculated by dividing their relative atom numbers with 2,18. The results are rounded off.

Thus the molar mass of an unit X can be calculated:

(**2** • 12 g / mol) + (**6** • 1 g / mol) + (**1** • 16 g / mol) = 46 g / mol

The ratio of the stoichiometric number corresponds already to the ratio of the formula searched for. You will, however, get the absolute values of the true indices only by multiplication with a factor n.

n = molar mass of compound / molar mass of the unit X

Our example:

46 g / mol / 46 g / mol = 1

In this case the stoichiometric numbers of the unit X and those of the compound formula searched for are already the same (multiplication with factor n = 1).

Another example:

Molar mass of the unit X: CH_2O = 30 g / mol.
Molar mass of the compound = 180 g / mol

180 g / mol / 30 g / mol = 6

According to this the compound formula is: $C_{1 \bullet 6} H_{2 \bullet 6} O_{1 \bullet 6} = C_6H_{12}O_6$

5.13 P1 ELEMENT PARTITION 1:

Parts of a compound – each element in %

Display	Keys	Actions / Comments

Enter Menu P1

1	Any display	Cm	Press (repeatedly) "**Cm**" (change to the next menu) until menu **P1** appears.

Continue with P1 (display **2a** or **2b** appears)

2a	P1 Element Part [%] M = 0 g/mol		Line 1: Menu abbreviation and name **Line 2:** **0 g** / **mol**; the last input of a compound formula / molar mass has been deleted with "**clr**" – **Continue with 3b**
2b	P1 Element Part [%] M = 180.157 g/mol e.g. molar mass of $C_6H_{12}O_6$		Line 1: Menu abbreviation and name **Line 2:** **Molar mass** of the last input (substance) **Continue with 3a** or **3b**

Continuation: 2 alternatives (**3a** – **3b**)

3a	**Take over the molar mass** for further calculations	=	**Press** " = " **Continue with 4**
3b	**Put in a new compound formula** (like in menu **M1**: ch. 5.2:, step **3a** – **5**)		
	P1 H_2 M = 1.0079 g/mol e.g. input of H_2SO_4	H 1 2 ...	**Put in a compound formula:** Press **element keys** (e.g. "**H** ^{1}") and **numerical keys** (e.g. "**2**")
	P1 Element Part [%] M = 98.0734 g/mol e.g. H_2SO_4: M = 98,0734 g / mol	=	**Press** " **=** " (after complete input) A new display appears: Line 1: Menu abbreviation and name **Line 2: Molar mass** **Continue with 3a**

Input: Mass percentage of the first element

4

Press " = ":
A new display appears.

```
P1  H2SO4
H = 2.0554 %
```

Line 1: Menu abbreviation / compound formula
Line 2: **Element / mass percentage**
Continue with 5.

Input: Mass percentage of the second element

5

Press " = ":
A new display appears.

```
P1  H2SO4
S = 32.6898 %
```

Line 1: Menu abbreviation / compound formula
Line 2: **Element / mass percentage**
Continue with 6

If necessary repeat step 5 (until all elements of the compound have been passed)

6

```
P1  H2SO4
O = 65.2548 %
```

After the last value:
Press " = "
Display **2b** or **3b** appears again (**7**)

Display: Molar mass like in **2b** or **3b**

7

```
P1  Element Part [%]
M = 98.0734 g/mol
```

e.g. H_2SO_4: M = 98,0734 g/mol

The mass percentage of all element have been displayed

(If you press " **=** ":
Repetition of mass percentages (**4-6**).

Formula:	$M_{element}$	•	index	/	$M_{compound}$	=	mass percentage
Our example:	M_H	•	index	/	$M_{H_2SO_4}$	=	mass percent. of **H**
H in: **H_2SO_4**	**1,008 g / mol**	•	**2**	/	**98,07 g / mol**	=	**0,02055 = 2,055 %**

5.14 P2 ELEMENT PARTITION 2:

Parts of a compound – each element in g

Display	Keys	Actions / Comments

Enter menu P2

1 Any display

```
P1  Element Part [%]
M = 0 g/mol
```

Press "**Cm**" (repeatedly) until menu **P1** appears.

Press "**Sm**": Menu **P2** appears (**2a** or **2b**).

Continue with menu P2 (display **2a** or **2b** appears)

2a

```
P2  Element Part [g]
M = 0 g/mol
```

Line 1: Menu abbreviation and name
Line 2: **0 g** / **mol**; compound formula / molar mass deleted with "**clr**" – **Continue with 3b**

2b

```
P2  Element Part [g]
M = 180.157 g/mol
```

e.g. molar mass of $C_6H_{12}O_6$

Line 1: Menu abbreviation and name
Line 2: **Molar mass** of the last input (substance)
Continue with 3a or **3b**

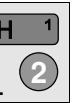
3a **Take over the molar mass** for further calculations

Press " = ": Continue with 4

3b **Input of a new compound formula** (like in menu **M1**: ch. 5.2:, step **3a** – **5**)

```
P2  H2
M = 1.0079 g/mol
```

e.g. input of H_2SO_4



Put in a compound formula:
Press **element keys** (e.g. "**H** ^{1}") and **numerical keys** (e.g. "**2**")

Press " = " (after complete input)
A new display appears:
Line 1: Menu abbreviation and name
Line 2: Molar mass
Continue with 3a

```
P2  Element Part [g]
M = 98.0734 g/mol
```

e.g. H_2SO_4: M = 98,0734 g / mol

Input: Mass of the compound

4

Press " = ":
A new display appears.

```
P2  m of sum
m = 0 g
```

Line 1: Menu abbreviation / explanation
Line 2: Zero is signalling.

Put in:
Mass of the substance
e.g. "**200**" g
(numerical keyboard)

Display: Mass part of the first element in g

5

```
P2  m of sum
m = 200 g
```

Press " = ":
A new display appears

```
P2  H2SO4
H = 4.1108 g
```

Line 1: Menu abbreviation / compound formula
Line 2: Element / mass part in g
Continue with 6

Display: Mass part of the second element in g

6

Press " = ":

```
P2  H2SO4
S = 65.3796 g
```

Line 1: Menu abbreviation / compound formula
Line 2: Element / mass part in g
Continue with 7

If necessary repeat step 6 (until all elements of the compound have been passed)

7	`P2  H2SO4` `O = 130.51 g`		After the last value: **Press " = "** Display **2b** or **3b** appears again (**7**).

Display: Molar Mass like in **2b** or **3b**

8	`P2  Element Part [g]`
	`M = 98.0734 g/mol`
	e.g. H_2SO_4: M = 98,0734 g / mol
		The mass part of all elements have been displayed.
		If you press " **=** ":
		Repetition of mass parts as in steps **4-6**.

Formula [1]

Mass parts of the elements expressed in parts of 1:

Formula:	$M_{element}$	•	index	/	$M_{compound}$	=	mass part	
Our example:	$\boldsymbol{M_H}$	•	index	/	$\boldsymbol{M_{H_2SO_4}}$	=	mass part of **H**	
H in H_2SO_4	**1,008 g / mol**	•	**2**	/	**98,07 g / mol**	=	**0,02055**	

Taken for granted a certain mass of the compound in g (e.g. 200g) the mass part of an element in g can be calculated as follows:

Formula:	mass part in part of 1	•	mass in g (compound)	=	mass part in g
Our example:	part of **H**		**H_2SO_4**		part of **H** in g
H in H_2SO_4	**0,02055**	•	**200 g**	=	**4,11 g**

Thus the part of **H** in **200g** of H_2SO_4 is: **4,11 g** (see. **5**).

[1] In the tables: ***M*** = molar mass

5.15 P3 FORMULA PARTITION 3:
Parts of a compound – several elements in %

	Display	Keys	Actions / Comments
Enter menu P3			
1	Any display	Cm	Press "**Cm**" (repeatedly) until menu **P1** appears.
	P1 Formula Part [%] M = 0 g/mol	Sm	Press "**Sm**" twice: Menu **P3** appears (**2**).
Continue with menu P3			
2	P3 Formula Part [%]		**Line 1: Menu abbreviation and name** Line 2: Nothing
		=	**Press " = "** **Continue with 3a** or **3b**
3a	P3 M = 0 g/mol		Line 1: Menu abbreviation **Line 2:** **0 g** / **mol**; formula / molar mass has been deleted with "**clr**" – **Continue with 4b**
3b	P3 $C_6H_{12}O_4$ M = 180.157 g/mol e.g. molar mass of $C_6H_{12}O_6$		Line 1: Menu abbreviation / compound formula **Line 2:** **Molar mass** of the last input (substance) **Continue with 4a** or **4b**
4a	**Take over the molar mass**:	=	**Press " = "** **Continue with 5.**

4b **Input of a new compound formula** (best method: entering menu **P1**)

It is not possible to put in a new formula in menu **P3**. Change to menu **P1**:

Press "**Sm**" twice:
Menu **P1** appears.

- **Put in a compound formula** as described for **P1**, step **3b** (see ch. 5.13, **3b**).
- Change again to menu **P3**:

Press "**Sm**" twice:
Menu **P3** appears (see step **2**)

Go on as described in step 2, 3b and 4a.
Our example for the compound formula put in in **4b** is H_2SO_4 (M = 98,0734 g / mol).

Put in: Any part of the compound formula

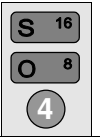
5 Our example: H_2SO_4

```
P3  Input Formula Part
M = 98.0734 g/mol
```

Line 1: Menu abbreviation / explanation
Line 2: Molar Mass of the substance

```
P3  SO4
M = 15.9994 g/mol
```

At first only the molar mass of the last element put in appears (not the value searched for).

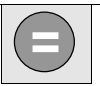


Put in any parts of the compound formula:
e.g. "**S 16**" ; "**O 8**" ; "**4**"

(any stoichiometric number is possible)

Result: Mass percentage of the part put in

6



Press " = ":
A new display appears:

```
P3  SO4
    97.9446 %
```

Line 1: Menu abbrev. / **formula part put in**
Line 2: **Mass percentage of formula part**
Continue with 7

Repetition of steps 3b until 6 (if necessary with new values)

7			**Press " = ":** Display **2** appears again. Steps 3b to 6 can be repeated.

Remarks

Step 5) It is possible to put in entire parts of the stoichiometric numbers.
After having pressed an element key in line 2 appears only the molar mass of this element. This value does not change after the input of a stoichiometric number. The input, however, is processed correctly.

Formula

$M_{element1}$	•	index	+	$M_{element\ 2}$	•	index	/	$M_{compound}$	=	mass percentage

Our example:

M_S	•	index	+	M_O	•	index	/	$M_{H_2SO_4}$	=	mass percent. **SO_4**
32,06 g / mol	•	**1**	+	**15,9994** g / mol	•	**4**	/	**98,07334** g / mol	=	0,97446 = **97,446 %**
96,0576 g / mol							/	**98,07334** g / mol	=	0,97446 = **97,446 %**

Thus the mass percentage of **SO_4** in **H_2SO_4** is **97,446 %** (see **6**).

5.16 P4 FORMULA PARTITION 4:
Parts of a compound – several elements in g

	Display	Keys	Actions / Comments
Enter menu P1			
1	Any display	Cm	Press"**Cm**" (repeatedly) until menu **P1** appears.
	P1 Element Part [%] M = 0 g/mol	Sm	Press "**Sm**" three times: Menu **P4** appears (**2**).
Continue with menu P4			
2	P4 Formula Part [g]	=	**Line 1: Menu abbreviation and name** Line 2: Nothing **Press " = "** **Continue with 3a** or **3b**
3a	P4 M = 0 g/mol		Line 1: Menu abbreviation **Line 2:** **0 g** / **mol**; formula / molar mass has been deleted with "**clr**" – **continue with 4b.**
3b	P4 $C_6H_{12}O_6$ M = 180.157 g/mol e.g. molar mass of $C_6H_{12}O_6$		Line 1: Menu abbreviation / compound formula **Line 2:** **Molar mass** of the last input (substance) **Continue with 4a** or **4b**.
4a	**Take over the molar mass**:	=	**Press " = "** **Continue with 5**

4b **Input of a new compound formula** (best method: entering menu **P1**)

It is not possible to put in a new formula in menu **P4**. Change to menu **P1**:

Press "**Sm**" once:
Menu **P1** appears.

- **Put in a compound formula** as described for **P1**, step **3b** (see ch. 5.13, **3b**).
- Change again to menu **P3**:

Press "**Sm**" three times:
Menu **P1** appears.

Go on as described in step 2, 3b and 4a.
Our example for the compound formula put in in **4b** is H_2SO_4 (M = 98,0734 g / mol).

Input: Any part of the compound formula

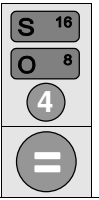
5 Our example: H_2SO_4:

```
P4  Input Formula Part
M = 98.0734 g/mol
```

```
P4  SO4
M = 15.9994 g/mol
```

At first only the molar mass of the last element put in appears.

Line 1: Menu abbreviation / explanation
Line 2: Molar Mass of the substance



Put in any parts of the compound formula:
e.g. "**S** **16**" ; "**0** **8**" ; "**4**"

(any stoichiometric number is possible)

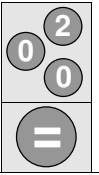
Press " = ":
A new display appears (**6**)

Input: Mass of the compound

6

```
P4  m of sum
m = 0 g
```

Line 1: Menu abbreviation / explanation
Line 2: **Zero is signalling.**



Put in:
Mass of the compound
e.g. "**200**" g
(numerical keyboard)

Press " = ":
The result appears (**7**).

Result: Mass of part put in

7	P4 SO_4 195.889 g	**Line 1:** Menu abbrev. / **formula part put in** **Line 2:** **Mass of formula part** in grammes **Continue with 8.**

Repetition of step 3b to 6 (if necessary with new values)

8			**Press " = ":** Display 2 appears again – You can repeat step 3b to 6.

Remarks

Step 5) It is possible to put in entire parts of the stoichiometric numbers.
After having pressed an element key in line 2 appears only the molar mass of this element. This value does not change after the input of a stoichiometric number. The input, however, is processed correctly.

Formula:

Calculation of the relative mass of the compound's part (our example: SO_4 in H_2SO_4):

$M_{element1}$	•	Index	+	$M_{element\ 2}$	•	Index	/	$M_{compound}$	=	rel. mass of part

Our example:

M_S	•	Index	+	M_O	•	Index	/	$M_{H_2SO_4}$	=	rel. mass of **SO_4**
32,06 g / mol	•	**1**	+	**15,99** g / mol	•	**4**	/	**98,0734** g / mol	=	**0,97446**
96,0576 g / mol							/	**98,0734** g / mol	=	**0,97446**

Taken for granted a certain mass of the compound in g (e.g. 200 g) the mass of a part of this compound in g can be calculated as follows:

Formula:	relative mass of a part	•	mass in g (compound)	=	mass of part in g
Our example: **SO_4** in **H_2SO_4**	rel. mass of **SO_4** **0,97446**	• •	**H_2SO_4** **200 g**	= =	mass of **SO_4** in g **195,89 g**

The part of **SO_4** in **200 g** of **H_2SO_4** is: **195,89 g** (see 7).

5.17 Lib LIBRARY: DATA OF THE ELEMENTS

	Display	Keys	Actions / Comments
Entering menu Lib			
1	Any display		Press (repeatedly) "**Cm**" (change to the next menu) until menu **Lib** appears.
	`Lib Library`		**Line 1:** **Menu abbreviation / menu name** Line 2: Nothing
2			Press an **element key** (e.g. "**H 1**"): A new display appears (1st entry).
	`Lib Hydrogen` `year of discovery 1766`		**Line 1:** **Menu / name of the element** **Line 2:** **Year of discovery: 1766**
Scrolling in the menu "Library"			
3	"**Scroll left**" (last entry) ➔ "**Scroll right**" (next entry) ➔		Press **Scroll-key**: The last or the next entry is indicated in the display.
	`Lib Hydrogen` `el.neg.(Paul.) 2.2`		**Line 1:** **Menu / name of the element** **Line 2:** **Electronegativity after Pauling**

Remarks

The following entries are made for each element:

year of discovery	
el.neg. [Paul.] (eV)	**electronegativity after Pauling (in: electron volt)**
density (g / cm^3)	**(in: gramm / cubic centimeter; gases in: g / dm^3)**
boiling pt (K)	**boiling point (in: Kelvin)**
melting pt (K)	**melting point (in: Kelvin)**
f.ion.pot. (eV)	**first ionization potential (in: electron volt)**
therm.conduct.	**thermic conductivity**

The order of this list corresponds with the order when calling up data with the key "Scroll right" (>).
Conversion of Kelvin into other temperature units: see ch. 7.

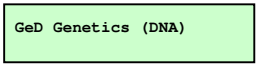
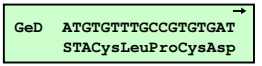
5.18 GeD GENETICS (DNA) – Input of a Nucleotide Sequence Number of different nucleotides / percentage of GC

Display	Keys	Actions / Comments

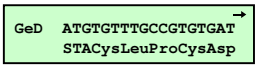
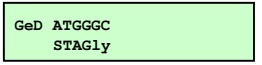
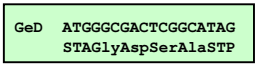
Enter menu GeD

1	Any display		Press (repeatedly) "**Cm**" (change to the next menu) until menu **GeD** appears.

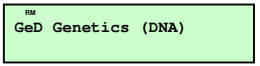
Continue with menu GeD (display **2a** or **2b** appears)

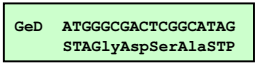
2a	 The last sequence has been deleted with „**clr**".		**Line 1: Menu abbreviation and name** Line 2: Nothing **Continue with 3b**
2b	 STA: Startcodon, aminoacids (three letters).		Automatic display of the last sequence: **Line 1: Menu abbreviation / sequence** **Line 2: Amino acid sequence** **Continue with 3a or 3b**

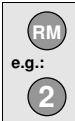
Continuation: 3 alternatives (**3a** – **3c**)

3a	**Take over the automatically displayed sequence**:  		Press " **=** " **Continue with 4**
3b	**Put in a new oligonucleotide** (the corr. aminoacid sequence appears in line 2)  After three bases automatically appears the coded aminoacid (or. Start- / Stop-Codon) in line 2.  	e.g.  ... 	Put in the nucleotide sequence: Press keys: "**B** [5]" – "**O** [8]". The 2nd functions of these keys (A, T, G, C) are automatically activated in menu **GeD** . Press " **=** " (after input of the whole sequence) **Continue with 4**

3c **Call up a nucleotide sequence from a memory place**





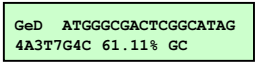


Press "**RM**"
Top line of the display: "RM" appears.
Press a key out of "**0**"–"**9**"
for the memory place
"RM" disappears.
Display:
Line 1: Menu abbreviation / **sequence**
Line 2: Amino acid sequence

Continue with 3a

Display: Number of nucleotides of each type / percentage of GC

4



Line 1: Menu abbreviation and name
Line 2: Number of each nucleotide type
(symbolized by A, T, U, G, C),
percentage of GC

Remarks

Step **2b** and **3b**

Scroll function

The input of a nucleotide sequence can reach beyond the display. This is indicated by arrows in the top line of the display at the left or right border. By using the scroll keys ( ) it is possible to move the displayed sequence. See ch. 3.3 with a detailled description.

Display of start and stop codons and amino acids in line 2

Start- und stop codons are symbolized by capitals (STA, STP) whereas aminoacids that do not serve as start- or stop codon are symbolized by the three letter code with only the first letter beeing a capital (e.g. Cys, Leu, ...).

Step **3b**

Maximal length of input possible:

The maximum length for the input of a oligonucleotide is 80 nucleotides.

Further processing of sequences in menus Ge1 – Ge6

- The input of a nucleotide sequence in **GeD** oder **GeR** is taken over into menus **Ge1** – **Ge6** and remains the base for further calculations there.
- A data input in **GeD** or **GeR** is processed similar in **Ge1** – **Ge6**. Difference: Concerning key "**C 6**" (2nd function "**T** / **U**") thymine ("**T**") is activated in **GeD**, Uracil ("U") in **GeR**.

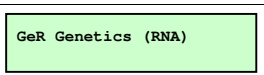
- The input of a sequence in **GeD** is also displayed in **GeR** and viceversa. Concerning display and calculations Thymine or Uracil replace each other.
- Only in **GeD** or **GeR** the input of a nucleotide sequence can be deleted by pressing the key "**clr**", not in the menus **Ge1** – **Ge6**.

5.19 GeR GENETICS (RNA) – Input of a Nucleotide Sequence: Number of different nucleotides / percentage of GC %

Steps 1 - 4 follow exactly the schedule described in ch. 5.18 for menu **GeD**. All remarks concerning **GeD** (pages 59-60) are also valid for menu **GeR**.

The only differences are:

- Instead of **GeD** the abbreviation **GeR** is used.
- Instead of Thymine ("**T**") in **GeR** Uracil ("**U**") is activated ("**T** / **U**" is 2nd function of key "**C 6**").

1	Any display		Press (repeatedly) "**Cm**" until menu **GeR** appears.
2a			The last sequence has been deleted by pressing the key "**clr**".
2b	The last input of a sequence is automatically displayed (automatic memory)		
3	**a)** Take over the automatically displayed sequence **b)** Put in a new sequence **c)** Call up a new sequence from a memory place		

4	**Display: Number of each nucleotide types / percentage of GC**

5.20 Ge1 MOLAR MASS (Nucleotide Strand, Coded Protein)

	Display	Keys	Actions / Comments
	Enter menu GeD or GeR		
1	Any display	Cm	Press (repeatedly) "**Cm**" until menu **GeD** or **GeR** appears.
	Continue with menu GeD or GeR		

2	`GeR Genetics (RNA)`
	`GeD ATGGGCGACTCGGCATAG`
	`STAGlyAspSerAlaSTP`
			Go on as described in ch. 5.18 (steps 2a – 4) and perform one of the three alternatives:
			a) Accept the automatically displayed sequence
			b) Put in a new sequence
			c) Call up a sequence from a memory space

	Enter Menü Ge1		
3	`GeD ATGGGCGACTCGGCATAG` `4A3T7G4C 61.11% GC`	Sm	Press "**Sm**" once: Menu **Ge1** appears (**4a**)
	Display: Different molecular weights		
4a	`Ge1 Molecular Weight 1` `M1 = 5547.6 g/mol`		Line 1: Menu abbreviation and name **Line 2: Molecular weight of the oligonucleotide as single strand**
		=	Press " **=** ": A new display appears (**4b**).
4b	`Ge1 Molecular Weight 2` `M2 = 11095.2g/mol`		Line 1: Menu abbreviation and name **Line 2: Molecular weight of the oligonucleotide as double strand**
		=	Press " **=** ": A new display appears (**4c**).

4b	Ge1 Molecular Weight 3 M3 = 461.475 g/mol	Line 1: Menu abbreviation and name **Line 2: Molecular weight of the amino acidsequence coded by the oligonucleotide**

Repetition of step **4a** – **4c**

5	=	Press " **=** ": A new display appears (**4a**)

Enter Submenu **Ge2**

6	Sm	Press "**Sm**" once: Menu **Ge2** appears

Formulas

DNA-Oligonucleotide (H at the 2'-end of the 2-Desoxy-D-Ribose):

Single strand: M_N = 1 • (a • 312.2 + g • 328.2 + c • 288.2 + t • 303.2 – 61) g/mol

Double strand: M_N = 2 • (a • 312.2 + g • 328.2 + c • 288.2 + t • 303.2 – 61) g/mol

RNA-Oligonucleotide (OH-group at the 2'-end of the D-Ribose; nucleotides with A, G and C have 16 g / mol more):

Single strand: M_N = 1 • (a • 328.2 + g • 344.2 + c • 304.2 + u • 305.2 – 61) g/mol

Double strand: M_N = 2 • (a • 328.2 + g • 344.2 + c • 304.2 + u • 305.2 – 61) g/mol

- **a**, **g**, **c, t** and **u** represent the nucleotides with **A**denin, **G**uanin, **C**ytosin, **T**hymin, **U**racil.
- The values for the bases are rounded to one significant number after the decimal point.
- The subtrahend „– 61" at the end of the formula is the rounded result of this calculation:
  $-M_{PO_4} + M_{OH} + M_{OH} \approx -$ 95 g/mol + 17 g/mol + 17 g/mol $\approx$ **– 61 g/mol**
  (no phosphate [PO_4] at the 5'-end of a single strand, instead of this an OH-group [OH];
  furthermore: OH-group at the 3'-end [OH], where no phosphate is bonded as ester)

Amino acid sequence (coded protein):

$M_{protein}$ = $M_{first\ amino\ acid}$ – 18 g/mol + $M_{second\ amino\ acid}$ – 18 g / mol + ... + $M_{last\ amino\ acid}$

- The amino acid is displayed in line 2 of menu **GeD** or **GeR**.
- The molar masses of the amino acids can be called up in menu **Ge6**.
- The calculation of the sequences' molar weight is based upon the values for amino acids as displayed in **Ge6**. 18 g/mol (= M_{H_2O}) are subtracted for the lost water when two amino acids bond.

5.21 Ge2 CALCULATION: Optical density into n (nmol)

Display	Keys	Actions / Comments
Enter menu GeD or GeR		
1 Any display		Press (repeatedly) "**Cm**" until menu **GeD** or **GeR** appears.
Continue with menu GeD or GeR		
2 `GeR Genetics (RNA)`		**Go on as described in ch. 5.18 (steps 2a – 4) and perform one of the three alternatives:** **a) Accept the automatically displayed sequence.** **b) Put in a new sequence.** **c) Call up a sequence from a memory space.**
Enter menu Ge2		
3 `GeD ATGGGCGACTCGGCATAG` `4A3T7G4C 61.11% GC`		Press "**Sm**" twice: Menu **Ge2** appears (**4a**)
Put in: Optical density (OD)		
4a `Ge2 OD → n[nmol]` `OD = 0`		Line 1: menu abbreviation / explanation **Line 2: Zero is signalling**
		Put in: Optical density: e.g. "**0,9**" (numerical keyboard)
`Ge2 OD → n[nmol]` `OD = 0.9`		Press " **=** ": A new display appears (**5**)
Result: Amount of substance in nmol		
5 `Ge2 ATGGGCGACTCGGCATAG` `n = 0.162232 nmol`		Line 1: Menu abbreviation / sequence **Line 2: Amount of substance in nmol**

Formula: See end of ch. 5.22

5.22 Ge3 CALCULATION: n (nmol) into optical density

Display	Keys	Actions / Comments

Enter menu GeD or GeR

1	Any display	Cm	Press (repeatedly) "**Cm**" until menu **GeD** or **GeR** appears.

Continue with menu GeD or GeR

2	`GeR Genetics (RNA)`		**Go on as described in ch. 5.18 (steps 2a – 4): and perform one of the three alternatives:** **a) Accept the automatically displayed sequence** **b) Put in a new sequence** **c) Call up a sequence from a memory space**

Enter menu Ge3

3	`GeD ATGGGCGACTCGGCATAG` `4A3T7G4C 61.11% GC`	Sm	Press "**Sm**" three times: Menu **Ge3** appears (**4a**)

Put in: the substance's amount in nmol

4a	`Ge3 nmol → OD` `n = 0 nmol`		Line 1: Menu abbreviation / explanation **Line 2: Zero is signalling**
		0 . 3	Put in: amount in nmol: e.g. "**0,3**" (numerical keyboard)
	`Ge3 n[nmol] → OD` `n = 0.3 nmol`	=	Press " **=** ": A new display appears (**5**)

Result: Optical density (OD)

5	`Ge2 ATGGGCGACTCGGCATAG` `OD = 1,66428`		Line 1: Menu abbreviation / sequence **Line 2: Optical density**

Formula (for ch. 5.21 and ch. 5.22)

Calculation in ch. 5.21:
A substance's amount in nmol corresponding to a certain optical density (OD)

$n = OD \bullet 1000 \ / \ \{M_N\}$ (nmol)

amount of substance (in: nmol) =
optical density (no dimension) • 1000 / value of molar mass of the nucleotide sequence

Calculation in ch. 5.22:
Optical density (OD) corresponding to a certain amount of substance in nmol (ch. 5.22):

$OD = \{n\} \bullet \{M_N\} \ / \ 1000$

Optical density (no dimension) =
value of amount of substance • value of molar mass of the nucleotide sequence / 1000

5.23 Ge4 CALCULATION: nmol into ng

Display	Keys	Actions / Comments

Enter menu GeD or GeR

1	Any display	Cm	Press (repeatedly) "**Cm**" until menu **GeD** or **GeR** appears.

Continue with menu GeD or GeR

2	`GeR Genetics (RNA)`	**Go on as described in ch. 5.18 (steps 2a – 4): and perform one of the three alternatives:** **a) Accept the automatically displayed sequence** **b) Put in a new sequence** **c) Call up a sequence from a memory space**

Enter menu Ge3

3	`GeD ATGGGCGACTCGGCATAG` `4A3T7G4C 61.11% GC`	Sm	Press "**Sm**" two / three times: Menu **Ge2** / **Ge3** appears (**4a**)

	`Ge3 nmol → OD`
	`n = 0.3 nmol`
	our example: „0.1" nmol in Ge3
			Put in either:
			In menu Ge2: An optical density (ch. 5.21) or:
			In menu Ge3: A substance's amount in nmol (ch. 5.22)

Enter menu Ge4 / result: mass of substance in ng

4	Line 2 in the display below: mass in ng for 100 nmol of the sequence used e.g. in ch. 5.22:	Sm	Press "**Sm**": Menu **Ge4** / the result appears (**4a**)
	`Ge4 nmol → m[ng]` `m = 1664.28 ng`		Line 1: Menu abbreviation / explanation **Line 2: The substance's amount in ng**

Formula:

$m_N = n \bullet M_N$

mass of the oligonucleotide (in: ng) = amount of substance (in: nmol) • molar mass (in: ng / nmol)

5.24 Ge5 MELTING TEMPERATURE OF THE OLIGONUCLEOTIDE

	Display	Keys	Actions / Comments
Enter menu GeD or GeR			
1	Any display	Cm	Press (repeatedly) "**Cm**" until menu **GeD** or **GeR** appears.
Continue with menu GeD or GeR			
2	`GeR Genetics (RNA)`		**Go on as described in ch. 5.18 (steps 2a – 4): and perform one of the three alternatives:** **a) Accept the automatically displayed sequence** **b) Put in a new sequence** **c) Call up a sequence from a memory space**
Enter menu Ge5			
3	`GeD ATGGGCGACTCGGCATAG` `4A3T7G4C 61.11% GC`	Sm	Press "**Sm**" five times: Menu **Ge5** appears (**4a**)
Put in: Concentration of Na^+			
4a	`Ge5 C[mol/l] → Tm[°C]` `C(Na+) = 0 mol/l`		Line 1: Menü abbreviation / explanation **Line 2: Zero is signalling**
		. 0 8	Put in: Concentration of Na^+ in mol/l: e.g. "**0,8**" mol/l (numerical keyboard)
	`Ge5 C[mol/l] → Tm[°C]` `C(Na+) = 0.8 mol/l`	=	Press " **=** ": A new display appears (**5**)
Result: Melting temperature in °C			
5	`Ge5 ATGGGCGACTCGGCATAG` `Tm = 75.0736 °C`		Line 1: Menu abbreviation / sequence **Line 2: Melting temperature in °C**

Remarks

Conversion of the temperature into another unit

The temperature displayed in °C can be converted into Kelvin oder °Fahrenheit (see ch. 7):

Press the keys "**2nd**" and "**4**" (function „**tu**" – temperature unit): Always after pressing these keys the temperature is displayed in another unit.

Formula:

$$T_m = 81{,}5\,°C + 16{,}6 \log [c(Na^+)] + 0{,}41\,(\%\,G + C) - 500 / n$$

T_m	melting temperature
81,5°C	Constante in °C
c(Na^+)	Concentration of Na^+ (input in **GeS**)
0,41	Constant
(% G + C)	percentage of Guanin and Cytosin The percentage of GC results from the input in **GeD** / **GeR** and is displayed there. This value is taken over automatically into menu **GeS**.
500 / **n**	**n** represents the number of nucleotides in the oligo. The number of each type of nucleotide (different bases A, T / U, G and C) is displayed in menu **GeD** / **GeR**. These numbers are automatically summed up and taken over into menu **GeS**.

5.25 Ge6 CODONS (BASE TRIPLETTS) OF AMINO ACIDS AND MOLAR MASS OF AMINOACIDS

	Display	Keys	Actions / Comments
Enter menu GeD or GeR			
1	Any display	Cm	Press (repeatedly) "**Cm**" until menu **GeD** or **GeR** appears.
2	`GeD Genetics (DNA)`		No input has to be performed in **GeD** / **GeR**, since **Ge6** is only a lexical function complementary to the menus concerning molecular biology. **Go on with 3**
Enter menu Ge6			
3	`GeD Genetics (DNA)`	Sm	Press "**Sm**" six times: Menu **Ge6** appears (4).
Menu Ge6: First display			
4	`Ge6 GCA GCC GCG GCU` `Alanine 89.093`		**Line 1:** **Menu abbreviation** / **base tripletts** **Line 2:** **Coded amino acid** / **molar mass**
Scroll: Moving in Ge6			
3	"**Scroll left**" (last data) ➔ "**Scroll right**" (next data) ➔	< >	**Press a scroll-key once**: The last or the next entry is displayed.
	`Ge6 AGA AGG CGA CGC` `Arginine 174.2`		**Line 1:** **Menu abbreviation** / **base tripletts** **Line 2:** **Coded amino acid** / **molar mass**
	`Ge6 CGG CGU` `Arginine 174.2`		If the display is not big enough to show all base tripletts that code the same amino acid at once, the tripletts left over are shown in the next display

Remark: See also the remarks at the end of ch. 5.20 (molar mass of amino acid sequences).

6 LEXICAL FUNCTIONS

6.1 CONSTANTS – FUNCTION "C"

This function serves to call up some important constants, that can be also used for further calculations:

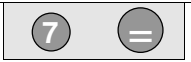
	Display	Keys	Actions / Comments
Enter function "C"			
1	Any display	2nd C 5	Press "**2nd**" and "**5**" (2^{nd} function of key "5": "**C**") Function "**C**" ist activated. A new display appears (**2**):
Display of the first entry			
2	`Calculator` N_A = 6.02252e+23 mol^{-1}		Line 1: Calculator **Line 2: Avogadro constant**
Moving in "C": Scroll			
3	"**Scroll left**" (last entry) ➔ "**Scroll right**" (next entry) ➔	< >	**Press a scroll-key once**: The last or the next entry is displayed.
	`Calculator` `F = 96485.1 C/mol`		Line 1: Calculator **Line 2: Faraday constant** (next entry)

Processing of data in the calculator mode

Press an operational key (e.g. "+" or "×"):

- The calculator leaves function "**C**"
- The value is displayed without formula sign and unit in line 2 (calculator mode).

Example: see next page

4	E.g.: Calculating with Avogadro's number in the calculator mode		Press "×" A new display appears:
	`Calculator` `6.02252e+23`		Line 1: Calculator (calculator mode) **Line 2: Value of the Avogadro constant** without formula sign and unit
5			Press "**7**" and "**=** " A new dispay appears:
	`Calculator` `4.21576e+24`		Line 1: Calculator (calculator mode) **Line 2: Result of the operation** e.g.: result of 6.02252 x 10^{+23} • 7

The following constants can be called up in this function:

N_A =	**6.02252 • 10^{23} mol^{-1}**	Avogadro constant (in: mol^{-1})
F =	**96485,1 C / mol**	Faraday constant (in: Coulomb / mol)
R =	**8,31451 J / (K × mol)**	(universal / molar) gas constant (in: Joule / Kelvin • mol)
h =	**6,62608 • 10^{-34} J s**	Planck constant (in: Joule • second)
k =	**1,38066 • 10^{-23} J / K**	Boltzmann constant (in: Joule / Kelvin)
ε_0 =	**8,854 • 10^{-12} F / m**	Electrical field constant (in: Faraday-constant / meter)
m_e =	**9,10994 • 10^{-28} g**	mass of an electron (in: gramm)
m_n =	**1,67493 • 10^{-24} g**	mass of a neutron (in: gramm)
m_p =	**1,67262 • 10^{-24} g**	masse of a Protons (in: gramm)
e =	**1,60218 • 10^{-19} C**	charge of an electron / elementary charge (in: Coulomb)
$V_{m,n}$ =	**22,4136 l / mol**	mole volume (Liter / mol)

Remark: Multiplications and other operations with two constants of "C" or of a constant of "C" with the atomic mass unit "u" (2^{nd} function of key "**6**") are only possible after memorizing the first value in one of 10 memory places (see ch. 9.2.2 p. 79).

6.2 ATOMIC MASS UNIT “u“

This function serves to call up the atomic mass unit ”u“, that can be also used for further calculations:

	Display	Keys	Actions / Comments
Enter function “u“			
1	Any display	2nd U 6	Press ”**2nd**“ and “**6**“ (2nd function of key ”6“: ”**u**“) Function ”**C**“ ist activated. A new display appears (**2**):
Continue with function “u“			
2	`Calculator` `u = 1.66054e-27 kg`		Line 1: Calculator **Line 2: Atomic mass unit u**
Processing of data in the calculator mode			

3	Example
	`Calculator`
	`1.66054e-27`
		×	Press “×“
			A new display appears:
			Line 1: Calculator (calculator mode)
			Line 2: Value of the atomic mass unit without formula sign and unit

5	`Calculator` `6.64216e-27`	4 =	Press “**4**“ and “**=** “ A new display appears: Line 1: Calculator (calculator mode) **Line 2: Result of the operation** e.g. result of $1.66054 \cdot 10^{-27} \cdot 4$

- **Press an operational key** (e.g. “+“ or “×“): The calculator leaves function “**C**“
- The value is displayed without formula sign and unit in line 2 (calculator mode).

Remark: Multiplication and other operations of the atomic mass unit with constants of function ”C“ can only be performed after memorizing the first value in one of 10 memory places (see ch. 9.2.2 p. 79).

6.3 LIBRARY – (Menu Lib)

In the menu **Lib** data of the chemical elements can be called up.
Detailled description: ch. 5.17, p. 56.

6.4 AMINO ACIDS (Menu Ge6)

In the menu **Ge6** base tripletts, that code an amino acid, and the molar mass of amino-acids can be called up. Detailled description: ch. 5.25, p. 68.

7 CONVERTING TEMPERATURES

Function "**u** – temperature unit" (2nd function of key "**4**"):
Conversion of temperatures in °Celsius, °Fahrenheit and Kelvin into one another.

You can enter this function:
- from the calculator mode (with "0" or any number put in)
- from a result in menu **Ge5** (ch. 5.24)

Calculator mode: Enter "tu" / put in: temperature in °C

	Display	Keys	Actions / Comments

1	Calculator mode:
	`Calculator`
	`0`
	Error appears (input is nonsense):
	`Calculator`
	`Error`
		2nd
		t u
		4
			Press "**2nd**" and „**4**"
			("**tu**" is the 2nd function of key "4")
			a) A new display appears (**2**):
			b) "Error" appears:
			The last value is nonsense,
			e.g.: „-300" (°C)
			Press "**2nd**" and "**4**" again
			A new display appears (**2**):

2	`Calculator`
	`0 °C`
	Display after overwriting:
	`Calculator`
	`55 °C`
			Line 1: Calculator
			Line 2: **Degrees in °C**/ signalling number (e.g. "0")
			Accept the number (leave it) or write over: e.g. with "55"
			Line 2: **55 °C** (the new value does not signal).

Conversion from °C into Kelvin /input of a temperature in Kelvin

3			Press "**2nd**" and "**4**" ("**tu**" is the 2nd function of key "4") Temperature in Kelvin appears (**4**)
4	Calculator 296.15 K		Line 1: Calculator. **Line 2:** **Degrees in Kelvin** / value signals. **Accept the value (leave it) or overwrite it:** our example: input of **"100"**
	Calculator 100 K		**Line 2:** **100 Kelvin** (value does not signal).
5	**Conversion from Kelvin into °F**/ input of a temperature in Kelvin: Go on analogous to step **3** and **4**.		

Summary:

°C ⇨ "2nd" and "4" ⇨ **Kelvin** ⇨ "2nd" and "4" ⇨ **°F** "2nd" and "4" ⇨ **°C** etc.

- **Press "2nd" und "4"** until you reach the temperature unit you want to convert.
- **Accept** the signalling value (leave it) **or overwrite** it with a new value.
- **Press "2nd" und "4"** until the temperature is converted into the wished unit.

Processing of data in the calculator mode

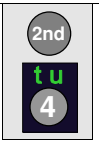
- **Press operational key** (e.g. "+" or "×"): The calculator leaves function "**tu**"
- The value is displayed without unit in line 2 (calculator mode).

6	Example: 121,22 Kelvin		Press "×": A new display appears:
	Calculator 121.22		Line 1: Calculator (calculator mode) **Line 2:** **Value of temperature** without unit
7			Press "**3**" and "**=**" A new display appears:
	Calculator 363.66		Line 1: Calculator (calculator mode) **Line 2:** **Result:** here: result of: 121,22 • 3

Entering function „tu“ from menu Ge5

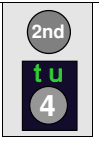
Display	Keys	Actions / Comments

Display of melting temp. in °C in menu Ge5: / conversion into Kelvin

1	**Result from Ge5** (vgl. Kap. 5.23)
	`Ge5 ATGGGCGACTCGGCATAG`
	`Tm = 75.0736 °C`
			Press “**2nd**“ and “**4**“
			(“**tu**“ is the 2nd function of key “4“)
			Line 2: Melting temperature in °C
			A new display appears (**2**):

	`Ge5 ATGGGCGACTCGGCATAG` `Tm = 348.224 K`		**Line 1: Nucleotide sequence** **Line 2: Temp. in Kelvin** (value does not signal) It is possible to replace the value.

Conversion of melting temperature: Kelvin into °F

2			Press “**2nd**“ and “**4**“ (“**tu**“ is the 2nd function of key “4“) A new display appears (**4**).
	`Ge5 ATGGGCGACTCGGCATAG` `Tm = 167.132 °F`		**Line 1: Nucleotide sequence** **Line 2: Degrees °F** (the value does not signal) It is possible to replace the value.

Conversion of melting temperature: Kelvin into °F

3	Proceed analogous to step **2**.

Order of keys:

°C ⇨ “2nd" and “4“ ⇨ **Kelvin** ⇨ “2nd" and “4“ ⇨ **°F** “2nd" and “4“ ⇨ **°C** etc.

Like described on the previous page after step 5.

8 CALCULATOR MODE

8.1 NUMERICAL KEYS

To the right of the periodic system keyboard are placed the numerical keys from "0" to "9" and a key for the input of decimal numbers (" . ").
The input is performed analogous to common pocket calculators.

8.2 OPERATION KEYS

To the right of the periodic system keyboard are the following operational keys:

Key	Function	Remarks
	**Addition**	• If pressed within a menu: The device changes into the calculator mode ("**`Calculator`**").
	**Subtraction**	• If pressed within a menu: The device changes into the calculator mode ("**`Calculator`**").
	**Multiplikation**	• If pressed within a menu: The device changes into the calculator mode ("**`Calculator`**").
	**Division**	• If pressed within a menu: The device changes into the calculator mode ("**`Calculator`**").
	**Change of sign**	
	**Exponent of 10** (see ch. 3.1.2, e)	• 2nd function of key " **+** "; press at first key "**2nd**" • A number, that has been put in before, is multiplicated with a power of 10 – possible from $\mathbf{10^{-37}}$ up to $\mathbf{10^{+37}}$.
	**Result**	

The operational keys are used analogous to common pocket calculators.

The function for setting brackets (2nd function of "%") is only active in the stoichiometric menus and can only be used for the input of compound formulas (see ch. 5.2 p. 24)!

8.3 FUNCTIONAL KEYS

To the right of the periodic system keyboard are the following functional keys:

Key	Function	Remarks
	**Reset key**	• Deletes the whole input displayed.
	**Clear error / clear**	• Deletes only the last input (for corrections of the entry). • Deletes an automatically displayed entry completely.
	**Activates / deactivates 2nd functions**	
	**Percent**	
	**Reciprocal value**	• 2nd function of key " **0** " ; press at first key "2nd". • If pressed within a menu: The device changes into the calculator mode ("**Calculator**").
	**2nd power (square)**	• 2nd function of key " **×** " ; press at first key "2nd" • If pressed within a menu: The device changes into the calculator mode ("**Calculator**").
	**Square root**	• 2nd function of key " **.** " ; press at first key "2nd" • If pressed within a menu: The device changes into the calculator mode ("**Calculator**").
	**x^th power of y**	• 2nd function of key " **±** " ; press at first key "2nd" • If pressed within a menu: The device changes into the calculator mode ("**Calculator**").
	**Common (base-10) logarithm**	• 2nd function of key " **÷** " ; press at first key "2nd" • If pressed within a menu: The device changes into the calculator mode ("**Calculator**").
	**Natural logarithm**	• 2nd function of key " **-** " ; press at first key "2nd" • If pressed within a menu: The device changes into the calculator mode ("**Calculator**").

The functional keys are used analogous to common pocket calculators.

9 MEMORY FUNCTIONS

9.1 AUTOMATIC MEMORY

The following data put in by the user or called up from a memory place (vgl. Kap. 9.2.3 and 9.2.4) are automatically memorized:

- **Compound formulas** in den stoichiometric menus (Input possible in **M1**, **C1** - **C3**, **P1** – **P4**) and
- **Nucleotide sequences** in the menus **GeD** and **GeR**.

These data are automatically displayed, if one of the menus is entered again.
This is not the case, if the last compound formula / nucleotide sequence has been deleted with key "**clr**"

- before the device is switched off (by pressing "**2nd**" and "**off**" respectively automatically after 2 minutes without any operation) or
- before pressing the key "**on**" during operation time (master-clear-key).

9.2 AUTOMATIC MEMORY

9.2.1 General Remarks

In every of the three functional areas of the device, i.e.

- calculator mode,
- stoichiometric functions,
- biochemical functions,

up to 10 memory places, that are independent from the automatic memory, can be used (alltogether 30 memory places). These memory places serve to memorize:

- **Numbers** in the calculator mode
- **Compound formulas** in the stoichiometric functions
- **Nucleotid sequences** in the biochemical functions

For memorizing data within one of these areas the user must assign the data to a memory place by pressing a numerical key:

Therefore the numerical keys "**1**" – "**9**" inclusive "**0**" can be used.

9.2.2 Calculator Mode

Memorizing a number

In the calculator mode it is possible to memorize:

- Any numbers in the calculator mode.
- The values of constants called up in function "**C**" (without formula sign and unit) and the value of the atomic mass unit "**u**" (without unit).

  Operations with two constants of "C" or of a constant of "C" with the atomic mass unit "u" (2nd function of key "**6**") are only possible after memorizing the first value in one of the 10 memory places (see ch. 6.1 and 6.2).

	Display	Keys	Actions / Comments
3b	RM Calculator u = 1.66054e-27 kg e.g. memorizing the value of the atomic mass unit "u"	2nd M RM 2	Press "**2nd**" "2nd" appears in display's top line. Press "**RM**" 2nd function "**M**" (memory) is activated. "2nd" disappears "RM" appears in the top line Press a numerical key ("**0**"–"**9**") for the memory place, e.g. "**2**" "RM" disappears

The value of the atomic mass unit can now be called from memory place "2".

Calling up a memorized number

	Display	Keys	Actions / Comments
3b	RM Calculator 0 Calculator 1.66054e-27 Here: Call-up of the value of "**u**" – e.g. for the multiplication: $\mathbf{N_A \bullet u}$	RM e.g.: 2	Press "**RM**" "RM" appears in display's top line. Press a numerical key ("**0**"–"**9**") for the memory place, e.g. "**2**" "RM" disappears Line 1: "Calculator" **Line 2:** **Value of the atomic mass unit** (without unit)

9.2.3 Stoichiometric Menus

Preliminaries

A memorized compound formulas can be called up in all stoichiometric menus, in which it is possible to put in such a formula (see the schedule in ch. 4, respectively the back-side of this manual).

Memorizing a compound formula is only possible in menu `M1`.

It is not possible to memorize a molar mass without the input of a compound formula (see ch. 5.2, step 3c and remarks on p. 25).

Memorizing a compound formula in menu `M1`

	Display	Keys	Actions / Comments

3b	RM
	`M1 C6H12O6`
	`M = 180.157 g/mol`
	e.g. memorizing the formula $C_6H_{12}O_6$
		2nd
		M RM
		2
			Press "**2nd**"
			"2nd" appears in display's top line.
			Press „**RM**"
			2nd function „**M**" (memory) is activated.
			"2nd" disappears.
			"RM" appears in the top line.
			Press a numerical key ("**0**"–"**9**") for the memory place, e.g. "**2**"
			"RM" disappears.

Calling up a memorized compound formula

	Display	Keys	Actions / Comments

3b	RM
	`M1 Molar Mass`
	`M = 0 g/mol`
	
	`M1 C6H12O6`
	`M = 180.157 g/mol`
		RM
		2
			Press „**RM**"
			„RM" appears in display's top line.
			Press a numerical key ("**0**"–"**9**") for the memory place, e.g. "**2**"
			„RM" disappears.
			Line 1: Compound formula
			Line 2: Molar mass

9.2.4 Molecular Biology (PCR)

Preliminaries

Memorizing or calling up a nucleotide sequence from a memory place is only possible in the menus GeD / GeR!

A nucleotide sequence put in or called up from a memory space in these menus remains the base for all calculations in the menus **Ge1** – **Ge5**. Changing a nucleotide sequence as calculation base is only possible in **GeD** / **GeR**.

***Memorizing a nucleotide sequence in menu* GeD / GeR**

	Display	Keys	Actions / Comments
3b	RM GeD ATGGGCGACTCGGCATAG STAGlyAspSerAlaSTP	2nd M RM 2	Press "**2nd**" "2nd" appears in display's top line. Press „**RM**" 2nd function "**M**" (memory) is activated. "2nd" disappears "RM" appears in the top line. Press a numerical key ("**0**"–"**9**") for the memory place, e.g. "**2**" "RM" disappears.

Calling up a memorized nucleotide sequence

3b	RM GeD Genetics (DNA) GeD ATGGGCGACTCGGCATAG STAGlyAspSerAlaSTP	RM 2	Press „**RM**" „RM" appears in display's top line. Press a numerical key ("**0**"–"**9**") for the memory place, e.g. "**2**" „RM" disappears. **Line 1: Nucleotide sequence** **Line 2: Amino acid sequence**

10 BATTERY CHANGE – WARRANTY

10.1 BATTERY CHANGE

You will get new batteries at your chemcode®-dealer!

Technical Data of the batteries

Type: CR 2025
Voltage: 2 x 3 V
Operation time: ca. 100 hours of operation

Keep the new batteries ready (2 pieces)

Change batteries, when the colour of displayed letters becomes too weak. After removing the two old batteries you have two minutes time during which all data memorized on one of the 30 memory places (see ch. 9.2) are kept.
Please keep the two new batteries ready before taking the old ones out!.

Open the battery case and remove the old batteries

Turn out the screw with a single slot on the left side of the battery case on the calculator's backside (a). Remove the cover of the battery case, the gum behind the batteries and afterwards the batteries.

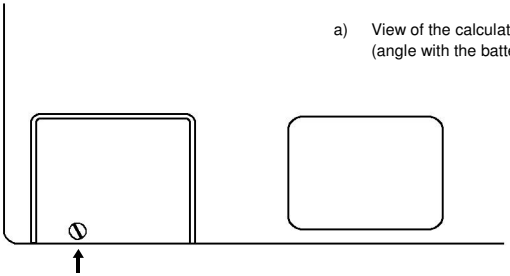
Put in the new batteries

Take the batteries with the inscription on the upper side (plus-pole) push them forward and to the left and right side of the battery case (circles mark the position).
Before closing the battery case again it is important to put the black gum behind the batteries again (b)! This gum is necessary for optimal performance of the power source.

Close the batterie case again

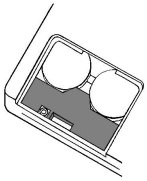
Push the notch at the inner edge of the cover unter the case of the device. Then press the outer edge of the cover down until it fits exactly. Take the screw and fasten it again.

Attention! Users may only open the cover (srew with a single slot). The screws with crossed slots of the calculator's case may not be be opened. (see ch. 10.2)!

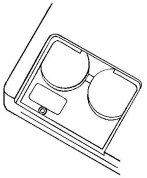


a) View of the calculator's backside (angle with the battery case)

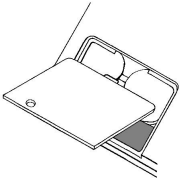
Screw for opening the battery case



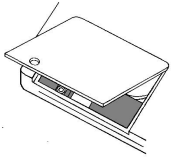
b) Battery case opened: Plus-pole of batteries with inscription orientated towards the user; the gum behind batteries is marked grey.



c) Battery case opened: The gum behind batteries has been removed.



d) Push the notch at the inner edge of the cover in the slot of the rim surrounding the opening of the battery case.



e) Press down the outer edge of the cover until it fits exactly and fasten it with the screw again.

10.2 WARRANTY

Each chemcode® has been checked thoroughly after production.

Should your item nonetheless have any defect not discovered by us, we will replace your item as quick as possible. Please turn to your chemcode®-dealer with the defect device.

In order to prove your claim please pay attention to the following points:

a) Keep your receipt and bring it to the dealer together with the chemcode®.
b) The identidy-code on a sticker below the batteries in the battery case should not have been removed.

There is no warranty for calculators, whose case has been opened by the user. Only the battery case may be opened (all screws with crossed slots must remain untouched). There is no warranty for devices, that have been opened or show other damages on the surface.

Warranty is orientated towards the legal statuses valid in Germany / the European Union.

11 EXPLANATION OF SYMBOLS AND ABBREVIATIONS

11.1 SYMBOLS AND ABBREVIATIONS IN THE DISPLAY

Abbrev. / Symbol	Explanation	See chapter
Calculator:	Calculator mode	2.1 / 8
C1	Menu C1 (Concentration 1)	5.7
C2	Menu C2 (Concentration 2)	5.8
C3	Menu C3 (Concentration 3)	5.9
Cx	Mass concentration of a substance x	
D	Menu D (Dilution)	5.11
Error	An input is false or has not been done	
F	Menu F (Formula)	5.12
GeD	Menu GeD (Genetics DNA)	5.18
GeR	Menu GeR (Genetics RNA)	5.19
g	Grammes	
K	Concentration in mass percentage	
Lib	Menu Lib (Library)	5.17
l	Liter	
M	Molar mass	
M1	Menu M1 (Molar mass)	5.2
M2	Menu M2 (amount of a substance: mol in g)	5.3
M3	Menu M3 (amount of a substance: g in mol)	5.4
M4	Menu M4 (ideal gas volume of a substance)	5.5
m	Mass	

Abbrev. / Symbol	Explanation	See chapter
mol	Unit „Mol“ – 1 Mol = 6,22 x 10^{23} particles	
n	Amount of substance	
P1	Menu P1 (Element Partition 1): Part of single elements in %	5.13
P2	Menu P2 (Element Partition 2): Part of single elements in g	5.14
P3	Menu P3 (Formula Partition 3): Part of several elements in %	5.15
P4	Menu P4 (Formula Partition 4): Part of several elements in in g	5.16
Sol	Menu SOL (Solution) Amount of a substance in g for preparing a solution	5.6
T	Menu T (Titration)	5.10
V	Volume	
V1	Final volume (Volumen 1)	5.11
V2	Initial volume (Volumen 2)	5.11
[x]	Concentration in mol / l	
[x]1	Final concentration in mol / l	5.11
[x]2	Initial value of concentration in mol / l	5.11
ρ	Density of a substance	5.9
ε_0	Electrical field constant	6.1

An underlined number in the display pictures symbolizes a signalling number.

11.2 ABBREVIATIONS ON KEYS AN THE CASE

11.2.1 Abbreviations on keys

Abbrev. / Symbol	Explanation	See chapter
2nd	The 2nd function of a key is activated / disactivated	1.3
clr	Clear / error correction	3.2.1
Cm	Change menu (next menu group is entered)	2.2
on	Switch on / reset key	1.2 / 3.2.2
RM	Read Memory	9
Sm	Submenu (next submenu in a menu group is entered)	2.3

11.2.2 Abbreviations on the geen lines of the case

Abbrev. / Symbol	Explanation		See chapter
1, 2, ...	Periods 1 – 7, elements of main groups	(black)	1.4
I a, II a, ...	Main groups	(black	1.4
1, 2, ...	Periods 1 – 7, transitory elements	(white)	1.4
I b, II b, ...	Transition groups	(white)	1.4
B	Bases of the nucleotides	(blue)	1.4
L	Lanthanoids	(blue)	1.4
A	Actinoids	(blue)	1.4

11.2.3 Abbreviations on the case (second function of keys)

Abbrev. / Symbol	Explanation		See chapter
A	Adenine	(blue)	5.18
T / **U**	Thymine / Uracil	(blue)	5.18
G	Guanine	(blue)	6.1
C	Cytosine	(blue)	5.18
M	Memory	(white)	9
off	Switch off	(white)	1.2
tu	Temperature unit	(green)	5.18
C	Constants	(green)	7
u	Atomic mass unit „u“	(green)	6.2

11.3 ABBREVIATIONS IN THE MANUAL'S TEXT

a.	and
abbrev.	abbreviation
ch.	chapter
corr.	corresponding
e.g.	exempli gratia (for example)
i.e.	id est
p. / pp.	page / pages
resp.	respective(ly)
stoichiom.	stoichiometric
temp.	temperature

12 FEEDBACK

Let us know about your opinion!

Having talked with many experts we know, that a product like the chemcode® meets the needs and interests of many persons.

Again and again we have used the informations collected in these conversations in order to improve the conception of the chemcode®.

E.g. all functions concerning biochemistry have been the result of the exchange with experts, to whom the integration of these features was of great importance.

We are convinced of the need for and the benefits of a product like the chemcode®. Nevertheless we are interested in getting feedback from our customers and want to know about their experiences in working with the chemcode® during daily routine.

Please use our website "**website"** in order to send us an e-mail:

www.chemcode.com

Or send us a message by **fax:**

0049 / (0)89 / 3 50 75 03

You will find some questions we are especially interested in on the next pages

We are looking forward to your feedback.

Your chemcode®- team

1) Did the chemcode® prove its worth during your daily routine in the laboratory and elswhere?

.....

.....

2) Do you have a need for the integration of further functions?

- Stoichiometry:

.....

.....

.....

- Molecular Biology:

.....

.....

.....

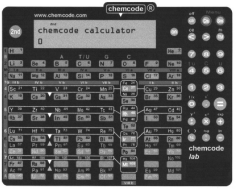
- Others:

.....

.....

Please contact us! We will always look very carefully at your concerns!

SHORT INSTRUCTIONS



It is advisable to study ch. 1 – 3 before using this device for the first time.
The single menus are self-explanatory to a high degree.
Details: see ch. 5.

a) on Press "**on**": The device is in the calculator mode (**`Calculator`**).

b) Cm Press "**Cm**" or an element key (e.g. Na 11): Change to menu **`M1`**.

c) Press "**Cm**" for entering the following menus/menu groups.

d) Sm "**Sm**": If there is a number behind a menu's abbreviation (or in **GeD** / **GeR**) submenus of this menu group are entered with the key "**Sm**":

Cm (→)	Compounds / Analysis										Data	Oligos	
`Calculator` →	**M1**	→ **SOL**	→ **C1**	→ T	→ D	→ F	→ **P1**	→ **Lib**	→ **GeD**	→ **GeR**
⇧	↓		↓				↓	↓	↓	
Press one time	**M2**		**C2**	Explanation of the menus' abbreviations: see contents (pp. 4 – 5)			**P2**	Press-element key and scroll	Ge1	Ge1
⇩	↓		↓				↓	↓	↓	↓
Sm (↓)	**M3**		**C3**				**P3**		Ge2	Ge2
	↓						↓	↓	↓	↓
	M4						**P4**		Ge3	Ge3
									↓	↓

- **Input of compound formulas** (possible in underlined menus): Change between element keys and numeric keys (for subscripts [stoichiometric numbers]).
- **Input of nucleotide sequences** (oligos) in **GeD** / **GeR**: Press the keys with the second functions **A**, **T** / **U**, **G**, **C**, which are automatically active in these menus.

e) = Key " **=** ": Moving forward within a menu (new input, indicating a result).

h) clr "**clr**": **1) Correcting** inputs (elements, subscripts, nucleotides, numbers). **2) Deleting** whole compound formulas/oligonucleotides, that have been put in completely (or called up by a memory function) and are processed.

i) < > **Scrolling**: **1)** If inputs reach beyond the display's frame (an arrow appears on the left or/and the right side of the display's top line), it is possible to scroll left or right by pressing these keys. **2)** Navigating through **`Lib`** / **`Ge6`**.