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# International Standard



# 4805

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INTERNATIONAL ORGANIZATION FOR STANDARDIZATION • МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ • ORGANISATION INTERNATIONALE DE NORMALISATION

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## Laboratory glassware — Thermo-alcoholometers and alcohol-thermohydrometers

*Verrerie de laboratoire — Alcoomètres et aréomètres pour alcool avec thermomètre incorporé*

First edition — 1982-11-15

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UDC 531.756.3 : 536.51

Ref. No. ISO 4805-1982 (E)

Descriptors : glassware, laboratory glassware, measuring instruments, hydrometers, alcohols, specifications, graduations, dimensions.

## Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 4805 was developed by Technical Committee ISO/TC 48, *Laboratory glassware and related apparatus*, and was circulated to the member bodies in September 1979.

It has been approved by the member bodies of the following countries :

|                |                        |                       |
|----------------|------------------------|-----------------------|
| Australia      | Hungary                | Poland                |
| Brazil         | Italy                  | Romania               |
| Canada         | Korea, Rep. of         | South Africa, Rep. of |
| France         | Libyan Arab Jamahiriya | Spain                 |
| Germany, F. R. | Netherlands            | USSR                  |

No member body expressed disapproval of the document.

# Laboratory glassware — Thermo-alcoholometers and alcohol-thermohydrometers

## 0 Introduction

ISO 4801 specifies alcoholometers and alcohol-hydrometers without an incorporated thermometer. In many countries, however, instruments with an incorporated thermometer are in use. The present International Standard specifies requirements for such instruments.

## 1 Scope and field of application

This International Standard specifies alcoholometers incorporating a thermometer (thermo-alcoholometers) and alcohol-thermohydrometers, suitable for general alcoholometric purposes.

The details specified are, as far as alcoholometer and hydrometer specifications are concerned, in conformity with ISO 387.

NOTE — The scale of alcoholometers is adjusted to allow direct readings of alcohol contents of alcohol-water mixtures. The scale of alcohol-hydrometers is graduated in density units (for example  $\text{kg/m}^3$ ), and their nominal range is particularly adapted to the requirements of alcoholometry.

## 2 References

ISO 386, *Liquid-in-glass laboratory thermometers — Principles of design, construction and use.*

ISO 387, *Hydrometers — Principles of construction and adjustment.*

## 3 General requirements

### 3.1 Definitions

#### 3.1.1 Alcohol

The term "alcohol" shall, in this International Standard, be understood as ethyl alcohol (ethanol,  $\text{C}_2\text{H}_5\text{OH}$ ).

**3.1.2 alcohol content by mass of a mixture of water and alcohol :** The ratio of the mass of alcohol present in the mixture to the total mass of the mixture.

The alcohol content by mass is expressed as the number of parts of alcohol per hundred parts of the mixture. The relevant symbol is "% mass".

NOTE — In ISO 78/2 and ISO 4801, the symbol "% (m/m)" is used. In the interest of alignment with the relevant OIML-Recommendation, however, preference should be given to the use of "% mass".

**3.1.3 alcohol concentration by volume of a mixture of water and alcohol :** The ratio of the volume of pure alcohol present in the mixture at 20 °C to the total volume of the mixture at the same temperature.

The alcohol concentration by volume is expressed as the number of volumes of alcohol per hundred volumes of the mixture. The relevant symbol is "% vol".

NOTE — In ISO 78/2 and ISO 4801, the symbol "% (V/V)" is used (see note in 3.1.2).

### 3.2 Density

The density of an alcohol-water mixture, where applicable, shall be expressed in kilograms per cubic metre.

### 3.3 Reference temperature

The reference temperature shall be 20 °C.

### 3.4 Construction

#### 3.4.1 General requirements

Alcoholometers and alcohol-hydrometers shall meet the requirements of ISO 387.

**3.4.1.1** Alcoholometers and alcohol-hydrometers shall be constructed of glass of suitable chemical and thermal properties, shall be as free as possible from visible defects and shall be reasonably free from internal stress.

The coefficient of cubical thermal expansion of the glass shall be  $(25 \pm 2) \times 10^{-6} \text{ }^\circ\text{C}^{-1}$ .

**3.4.1.2** The loading material shall be such that after the finished instrument has been kept in a horizontal position for

1 h at 80 °C and subsequently cooled to room temperature in that position, the instrument shall meet the requirements of 3.4.1.3.

**3.4.1.3** The instrument shall float with its axis vertical to within 1 degree 30 minutes.

**3.4.1.4** The thermometer shall be provided with an expansion volume, which allows heating up to a temperature slightly above 80 °C.

**3.4.2 Scales**

**3.4.2.1** Scales and inscriptions shall be marked on a smooth matt surface. Graduations within the nominal scale limits and inscriptions shall be marked in black. Graduations outside the nominal scale limits (see 3.4.2.2 and 3.4.2.3) may be marked in a colour other than black.

**3.4.2.2** Alcoholometer and hydrometer scales shall carry two to ten additional graduation lines beyond the nominal limits at both ends.

**3.4.2.3** Thermometer scales shall carry two to four additional graduation lines beyond the nominal limits at both ends.

**3.4.2.4** Indelible datum lines of thickness comparable with that of the scale lines shall be provided

- at the highest figured graduation line of alcoholometer (hydrometer) scales;
- at the lowest figured graduation line of thermometer scales.

NOTE — Alternatively, the latter may be confined to the graduation line at 20 °C.

**3.5 Basis of adjustment**

**3.5.1 Reading**

The instrument shall be graduated for reading at the level of the free surface of the liquid.

**3.5.2 Scale subdivision and limits of error**

See table 1.

**3.5.3 Relation between alcohol mass content, density and surface tension of alcohol-water mixtures**

See table 2.

**3.5.4 Relation between alcohol volume concentration, density and surface tension of alcohol-water mixtures**

See table 3.

**3.5.5 Wetting**

For correct reading, the stem shall not be wetted more than a few millimetres above the liquid surface.

**3.6 Inscriptions**

The following shall be legibly and indelibly marked on each instrument :

- appropriate inscriptions according to ISO 387;
- the basis of scale, for example % mas, % vol or kg/m<sup>3</sup>;
- the word ethanol or ethyl alcohol or the symbol C<sub>2</sub>H<sub>5</sub>OH;
- any other inscription, for example as required by national legal metrology;
- reference to the appropriate International or national Standard.

**4 Requirements for thermo-alcoholometers for mass content**

**4.1 Scales**

**4.1.1 Length of graduation lines**

- a) every tenth graduation line shall be a long line;
- b) there shall be a medium line between two consecutive long lines;
- c) there shall be four short lines between consecutive medium and long lines.

(See figure 1.)

Table 1 — Scale subdivision and limit of error

| Alcoholometer         |                         | Thermometer      |                      |                |
|-----------------------|-------------------------|------------------|----------------------|----------------|
| Scale subdivision     | Limit of error          | Nominal range °C | Scale subdivision °C | Limit of error |
| 0,1 % vol             | ± 0,1 % vol             | 5 to 25          | 0,2                  | ± 0,2          |
| 0,1 % mas             | ± 0,1 % mas             |                  |                      |                |
| Alcohol-hydrometer    |                         | 0 to 30          |                      |                |
| 0,2 kg/m <sup>3</sup> | ± 0,2 kg/m <sup>3</sup> |                  |                      |                |

Table 2 — Alcohol mass content by mass, density and surface tension at 20 °C

| Alcohol mass content | Density           | Surface tension | Alcohol mass content | Density           | Surface tension | Alcohol mass content | Density           | Surface tension |
|----------------------|-------------------|-----------------|----------------------|-------------------|-----------------|----------------------|-------------------|-----------------|
| % mas                | kg/m <sup>3</sup> | mN/m            | % mas                | kg/m <sup>3</sup> | mN/m            | % mas                | kg/m <sup>3</sup> | mN/m            |
| 0                    | 998,20            | 72,6            | 40                   | 935,15            | 29,9            | 80                   | 843,39            | 24,8            |
| 1                    | 996,31            | 67,1            | 41                   | 933,10            | 29,7            | 81                   | 840,91            | 24,7            |
| 2                    | 994,49            | 63,0            | 42                   | 931,03            | 29,5            | 82                   | 838,43            | 24,6            |
| 3                    | 992,73            | 60,1            | 43                   | 928,94            | 29,3            | 83                   | 835,93            | 24,5            |
| 4                    | 991,02            | 57,8            | 44                   | 926,82            | 29,1            | 84                   | 833,41            | 24,4            |
| 5                    | 989,38            | 55,7            | 45                   | 924,69            | 28,9            | 85                   | 830,88            | 24,3            |
| 6                    | 987,78            | 53,8            | 46                   | 922,53            | 28,8            | 86                   | 828,32            | 24,2            |
| 7                    | 986,24            | 52,1            | 47                   | 920,37            | 28,6            | 87                   | 825,75            | 24,1            |
| 8                    | 984,73            | 50,5            | 48                   | 918,18            | 28,5            | 88                   | 823,15            | 24,0            |
| 9                    | 983,27            | 49,1            | 49                   | 915,98            | 28,3            | 89                   | 820,53            | 23,8            |
| 10                   | 981,85            | 47,8            | 50                   | 913,77            | 28,2            | 90                   | 817,88            | 23,7            |
| 11                   | 980,46            | 46,6            | 51                   | 911,55            | 28,1            | 91                   | 815,21            | 23,6            |
| 12                   | 979,10            | 45,5            | 52                   | 909,31            | 28,0            | 92                   | 812,49            | 23,5            |
| 13                   | 977,76            | 44,4            | 53                   | 907,07            | 27,8            | 93                   | 809,75            | 23,4            |
| 14                   | 976,44            | 43,4            | 54                   | 904,81            | 27,7            | 94                   | 806,97            | 23,2            |
| 15                   | 975,13            | 42,5            | 55                   | 902,55            | 27,6            | 95                   | 804,14            | 23,1            |
| 16                   | 973,83            | 41,6            | 56                   | 900,28            | 27,5            | 96                   | 801,27            | 23,0            |
| 17                   | 972,54            | 40,7            | 57                   | 897,99            | 27,3            | 97                   | 798,36            | 22,8            |
| 18                   | 971,24            | 39,9            | 58                   | 895,70            | 27,2            | 98                   | 795,38            | 22,7            |
| 19                   | 969,93            | 39,1            | 59                   | 893,40            | 27,1            | 99                   | 792,35            | 22,6            |
| 20                   | 968,61            | 38,3            | 60                   | 891,10            | 27,0            | 100                  | 789,24            | 22,4            |
| 21                   | 967,27            | 37,7            | 61                   | 888,78            | 26,9            | 101*                 | 786,13            | 22,3            |
| 22                   | 965,90            | 37,0            | 62                   | 886,46            | 26,8            | 102*                 | 783,02            | 22,2            |
| 23                   | 964,51            | 36,4            | 63                   | 884,13            | 26,7            | 103*                 | 779,91            | 22,1            |
| 24                   | 963,09            | 35,8            | 64                   | 881,79            | 26,6            | 104*                 | 776,80            | 22,0            |
| 25                   | 961,63            | 35,2            | 65                   | 879,45            | 26,5            | 105*                 | 773,69            | 21,9            |
| 26                   | 960,14            | 34,7            | 66                   | 877,09            | 26,4            | 106*                 | 770,58            | 21,8            |
| 27                   | 958,61            | 34,2            | 67                   | 874,73            | 26,3            |                      |                   |                 |
| 28                   | 957,05            | 33,7            | 68                   | 872,37            | 26,2            |                      |                   |                 |
| 29                   | 955,44            | 33,3            | 69                   | 869,99            | 26,1            |                      |                   |                 |
| 30                   | 953,78            | 32,8            | 70                   | 867,61            | 26,0            |                      |                   |                 |
| 31                   | 952,09            | 32,5            | 71                   | 865,22            | 25,8            |                      |                   |                 |
| 32                   | 950,36            | 32,1            | 72                   | 862,83            | 25,7            |                      |                   |                 |
| 33                   | 948,58            | 31,8            | 73                   | 860,43            | 25,6            |                      |                   |                 |
| 34                   | 946,77            | 31,4            | 74                   | 858,02            | 25,5            |                      |                   |                 |
| 35                   | 944,92            | 31,1            | 75                   | 855,60            | 25,4            |                      |                   |                 |
| 36                   | 943,03            | 30,9            | 76                   | 853,17            | 25,3            |                      |                   |                 |
| 37                   | 941,11            | 30,6            | 77                   | 850,74            | 25,2            |                      |                   |                 |
| 38                   | 939,15            | 30,3            | 78                   | 848,30            | 25,1            |                      |                   |                 |
| 39                   | 937,16            | 30,1            | 79                   | 845,85            | 25,0            |                      |                   |                 |

\* Tables 2 and 3 include imaginary alcohol contents of more than 100 %. Those figures are necessary for the adjustment of alcoholometers and represent the case of highly concentrated alcohol-water mixtures at temperatures between 20 and 40 °C, the density of which, formally, corresponds to alcohol contents above 100 %.

Table 3 — Alcohol volume concentration by density and surface tension at 20 °C

| Alcohol volume concentration | Density           | Surface tension | Alcohol volume concentration | Density           | Surface tension | Alcohol volume concentration | Density           | Surface tension | Alcohol volume concentration | Density           | Surface tension |
|------------------------------|-------------------|-----------------|------------------------------|-------------------|-----------------|------------------------------|-------------------|-----------------|------------------------------|-------------------|-----------------|
| % vol                        | kg/m <sup>3</sup> | mN/m            |
| 0                            | 998,20            | 72,6            | 30                           | 962,21            | 35,4            | 60                           | 909,11            | 27,9            | 85                           | 844,85            | 24,9            |
| 1                            | 996,70            | 68,1            | 31                           | 960,95            | 35,0            | 61                           | 906,87            | 27,8            | 86                           | 841,84            | 24,8            |
| 2                            | 995,23            | 64,5            | 32                           | 959,66            | 34,5            | 62                           | 904,60            | 27,7            | 87                           | 838,77            | 24,6            |
| 3                            | 993,81            | 61,7            | 33                           | 958,34            | 34,1            | 63                           | 902,31            | 27,6            | 88                           | 835,64            | 24,5            |
| 4                            | 992,41            | 59,6            | 34                           | 956,98            | 33,7            | 64                           | 899,99            | 27,4            | 89                           | 832,45            | 24,4            |
| 5                            | 991,06            | 57,8            | 35                           | 955,59            | 33,3            | 65                           | 897,65            | 27,3            | 90                           | 829,18            | 24,2            |
| 6                            | 989,73            | 56,1            | 36                           | 954,15            | 32,9            | 66                           | 895,28            | 27,2            | 91                           | 825,83            | 24,1            |
| 7                            | 988,43            | 54,5            | 37                           | 952,69            | 32,6            | 67                           | 892,89            | 27,1            | 92                           | 822,39            | 23,9            |
| 8                            | 987,16            | 53,1            | 38                           | 951,18            | 32,3            | 68                           | 890,48            | 27,0            | 93                           | 818,85            | 23,8            |
| 9                            | 985,92            | 51,8            | 39                           | 949,63            | 31,9            | 69                           | 888,03            | 26,9            | 94                           | 815,18            | 23,6            |
| 10                           | 984,71            | 50,5            | 40                           | 948,05            | 31,7            | 70                           | 885,56            | 26,7            | 95                           | 811,38            | 23,4            |
| 11                           | 983,52            | 49,4            | 41                           | 946,42            | 31,4            | 71                           | 883,06            | 26,6            | 96                           | 807,42            | 23,3            |
| 12                           | 982,35            | 48,3            | 42                           | 944,76            | 31,1            | 72                           | 880,54            | 26,5            | 97                           | 803,27            | 23,1            |
| 13                           | 981,21            | 47,2            | 43                           | 943,06            | 30,9            | 73                           | 877,99            | 26,4            | 98                           | 798,90            | 22,9            |
| 14                           | 980,08            | 46,3            | 44                           | 941,32            | 30,6            | 74                           | 875,40            | 26,3            | 99                           | 794,25            | 22,6            |
| 15                           | 978,97            | 45,4            | 45                           | 939,54            | 30,4            | 75                           | 872,79            | 26,2            | 100                          | 789,24            | 22,4            |
| 16                           | 977,87            | 44,5            | 46                           | 937,73            | 30,2            | 76                           | 870,15            | 26,1            | 101*                         | 783,75            | 22,2            |
| 17                           | 976,79            | 43,7            | 47                           | 935,88            | 30,0            | 77                           | 867,48            | 25,9            | 102*                         | 778,26            | 22,0            |
| 18                           | 975,71            | 42,9            | 48                           | 934,00            | 29,8            | 78                           | 864,78            | 25,8            | 103*                         | 772,77            | 21,8            |
| 19                           | 974,63            | 42,1            | 49                           | 932,09            | 29,6            | 79                           | 862,04            | 25,7            | 104*                         | 767,28            | 21,6            |
| 20                           | 973,56            | 41,4            | 50                           | 930,14            | 29,4            | 80                           | 859,27            | 25,6            |                              |                   |                 |
| 21                           | 972,48            | 40,7            | 51                           | 928,16            | 29,3            | 81                           | 856,46            | 25,4            |                              |                   |                 |
| 22                           | 971,40            | 40,0            | 52                           | 926,16            | 29,1            | 82                           | 853,62            | 25,3            |                              |                   |                 |
| 23                           | 970,31            | 39,3            | 53                           | 924,12            | 28,9            | 83                           | 850,74            | 25,2            |                              |                   |                 |
| 24                           | 969,21            | 38,7            | 54                           | 922,06            | 28,8            | 84                           | 847,82            | 25,0            |                              |                   |                 |
| 25                           | 968,10            | 38,1            | 55                           | 919,96            | 28,6            |                              |                   |                 |                              |                   |                 |
| 26                           | 966,97            | 37,5            | 56                           | 917,84            | 28,5            |                              |                   |                 |                              |                   |                 |
| 27                           | 965,81            | 37,0            | 57                           | 915,70            | 28,3            |                              |                   |                 |                              |                   |                 |
| 28                           | 964,64            | 36,4            | 58                           | 913,53            | 28,2            |                              |                   |                 |                              |                   |                 |
| 29                           | 963,44            | 35,9            | 59                           | 911,33            | 28,1            |                              |                   |                 |                              |                   |                 |

\* Tables 2 and 3 include imaginary alcohol contents of more than 100 %. Those figures are necessary for the adjustment of alcoholometers and represent the case of highly concentrated alcohol-water mixtures at temperatures between 20 and 40 °C, the density of which, formally, corresponds to alcohol contents above 100 %.

#### 4.1.2 Thickness of graduation lines

Graduation lines shall be of uniform thickness not exceeding one-fifth of the distance between the centres of adjacent scale lines or 0,2 mm, whichever is less.

#### 4.1.3 Numbering of graduation lines

Each graduation line corresponding to a whole unit percent of alcohol shall be numbered in full.

### 4.2 Nominal ranges

The nominal range of each instrument shall be 5 % mas. Each instrument shall carry two to ten additional graduations beyond the nominal limits at both ends of its scale.

Thus, the series of nominal ranges is 0 to 5 % mas . . . 95 to 100 % mas. An additional alcoholometer may be included, covering a nominal range of 98 to 103 % mas (see note to tables 2 and 3).

### 4.3 Dimensions

The instruments shall meet the dimensional requirements given in figure 2.

The body of the instruments shall be so constructed as to result in a volume of 60 to 80 ml.

## 5 Requirements for thermo-alcoholometers for volume concentration

### 5.1 Scales

#### 5.1.1 Length of graduation lines

- a) every tenth graduation line shall be a long line;
- b) there shall be a medium line between two consecutive long lines;
- c) there shall be four short lines between consecutive medium and long lines.

(See figure 1.)

#### 5.1.2 Thickness of graduation lines

Graduation lines shall be of uniform thickness not exceeding one-fifth of the distance between the centres of adjacent scale lines or 0,2 mm, whichever is less.

#### 5.1.3 Numbering of graduation lines

Each graduation line corresponding to a whole unit per cent of alcohol shall be numbered in full.

### 5.2 Nominal ranges

The nominal range of each instrument shall be 5 % vol.

Each instrument shall carry two to ten additional graduations beyond the nominal limits at both ends of its scale.

Thus, the series of nominal ranges is 0 to 5 % vol . . . 95 to 100 % vol. An additional alcoholometer may be included, covering a nominal range of 95 to 103 % vol (see note to tables 2 and 3).

### 5.3 Dimensions

The instruments shall meet the dimensional requirements given in figure 2.

The body of the instruments shall be so constructed as to result in a volume of 60 to 80 ml.

## 6 Requirements for alcohol-thermohydrometers

### 6.1 Scales

#### 6.1.1 Length of graduation lines

- a) Every fifth graduation line shall be a long line;
- b) there shall be four short lines between two consecutive long lines.

(See figure 3.)

#### 6.1.2 Thickness of graduation lines

Graduation lines shall be of uniform thickness not exceeding one-fifth of the distance between the centres of adjacent scale lines or 0,2 mm, whichever is less.

#### 6.1.3 Numbering of graduation lines

Every tenth line shall be numbered, and (with the exception of the nominal scale limits) may be partially numbered if required.

### 6.2 Nominal range

The nominal range of the alcohol-thermohydrometer is 785 to 805 kg/m<sup>3</sup>.

### 6.3 Dimensions

The instruments shall meet the dimensional requirements given in figure 4.

$a = 0,2 U$   
 $b = 0,33 U$   
 $c = 0,5 U$   
 $U = \text{stem circumference}$

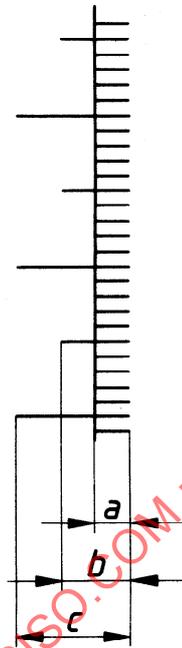


Figure 1 — Thermo-alcoholometers — Lengths of graduation lines

Dimensions in millimetres

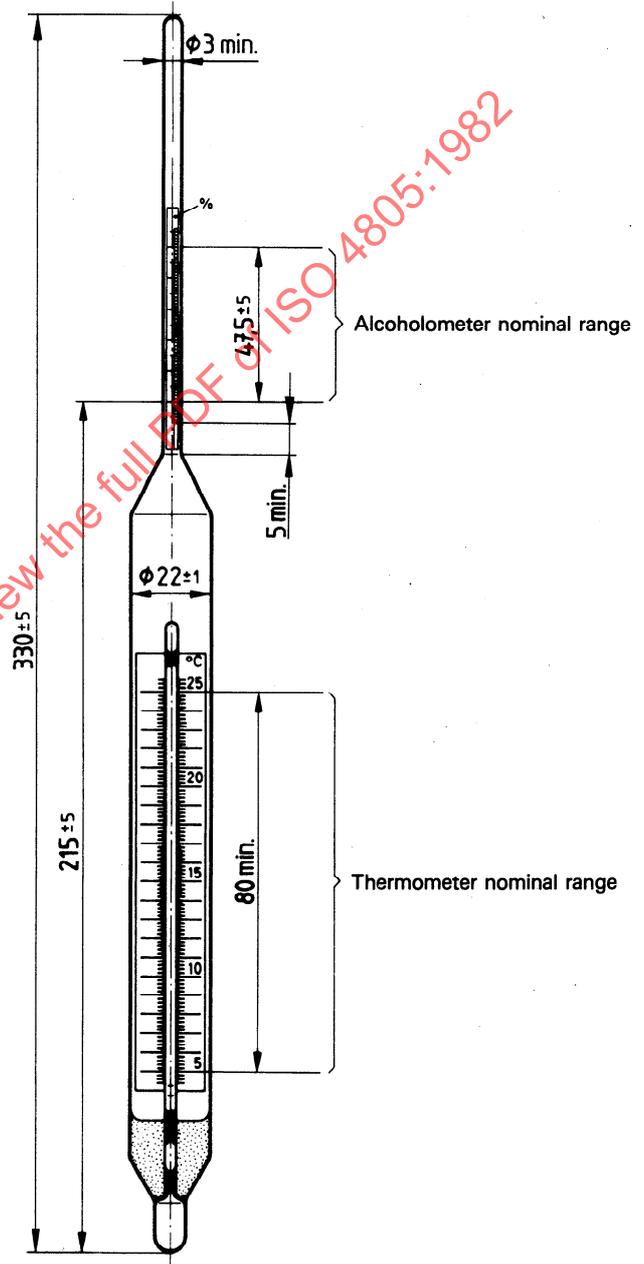


Figure 2 — Thermo-alcoholometers — Dimensions

Dimensions in millimetres

$a = 0,2 U$   
 $c = 0,5 U$   
 $U = \text{stem circumference}$

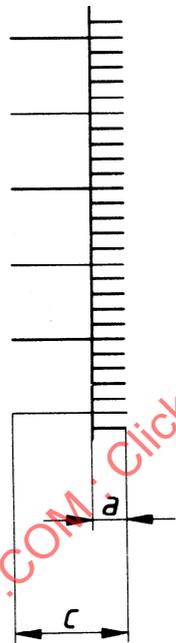


Figure 3 — Alcohol-thermohydrometers — Lengths of graduation lines

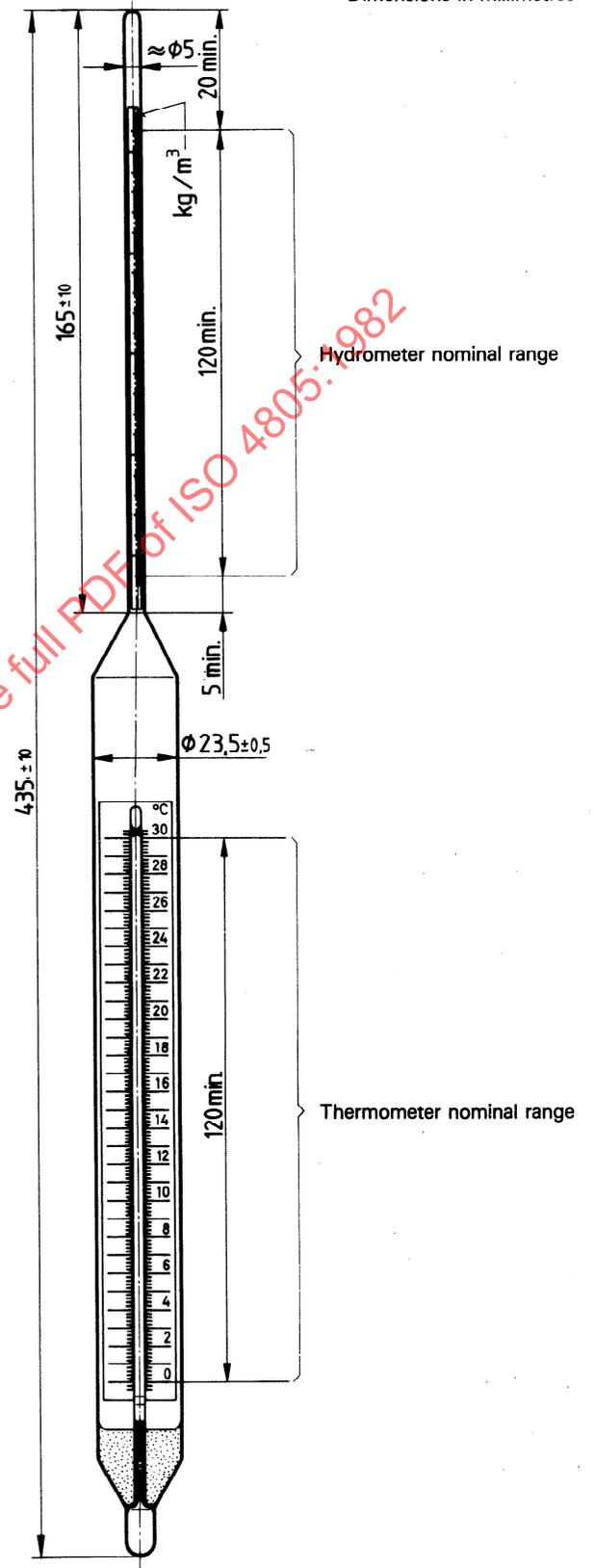


Figure 4 — Alcohol-thermohydrometers — Dimensions