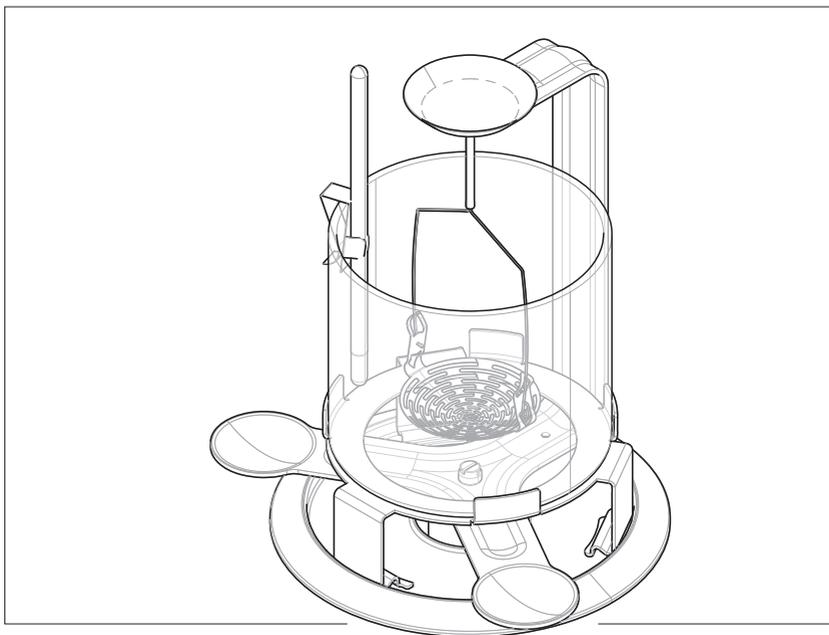


for Advanced and Standard Analytical Balances



**METTLER TOLEDO**



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# 1 Introduction

Thank you for choosing a METTLER TOLEDO density kit.

The density kit allows you to determine the density of solids and liquids. The kit is compatible with a wide range of advanced, standard, and jewelry analytical balances. A complete list of compatible balances can be found in [Compatibility table ▶ Page 6].

## 1.1 Further documents and information

▶ [www.mt.com/lab-accessories](http://www.mt.com/lab-accessories)

This document is available in other languages online.

▶ [www.mt.com/Density-Kit-advanced-RM](http://www.mt.com/Density-Kit-advanced-RM)

Search for documents

▶ [www.mt.com/library](http://www.mt.com/library)

For further questions, please contact your authorized METTLER TOLEDO dealer or service representative.

▶ [www.mt.com/contact](http://www.mt.com/contact)

## 1.2 Explanation of conventions and symbols used

### Conventions and symbols

 **Note** For useful information about the product.



Refers to an external document.

### Elements of instructions

In this manual, step-by-step instructions are presented as follows. The action steps are numbered and can contain prerequisites, intermediate results and results, as shown in the example. Sequences with less than two steps are not numbered.

- Prerequisites that must be fulfilled before the individual steps can be executed.

1 Step 1

⇒ Intermediate result

2 Step 2

⇒ Result

## 1.3 Acronyms and abbreviations

Original term	Explanation
RM	Reference Manual

## 2 Safety information

- This Reference Manual contains a full description of the instrument and its use.
- Keep the Reference Manual for future reference.
- Include the Reference Manual if you transfer the instrument to other parties.

Only use the instrument according to the Reference Manual. If you do not use the instrument according to the Reference Manual or if it is modified, the safety of the instrument may be impaired and Mettler-Toledo GmbH assumes no liability.

### 2.1 Definitions of signal words and warning symbols

Safety notes contain important information on safety issues. Ignoring the safety notes may lead to personal injury, damage to the instrument, malfunctions and false results. Safety notes are marked with the following signal words and warning symbols:

#### Signal words

<b>DANGER</b>	A hazardous situation with high risk, resulting in death or severe injury if not avoided.
<b>WARNING</b>	A hazardous situation with medium risk, possibly resulting in death or severe injury if not avoided.
<b>CAUTION</b>	A hazardous situation with low risk, resulting in minor or moderate injury if not avoided.
<b>NOTICE</b>	A hazardous situation with low risk, resulting in damage to the instrument, other material damage, malfunctions and erroneous results, or loss of data.

#### Warning symbols



Notice

### 2.2 Product-specific safety notes

#### Intended use

This instrument is intended to be used by trained staff. The density kit is designed to be installed on a range of METTLER TOLEDO analytical balances to determine the density of solids and liquids.

Any other type of use and operation beyond the limits of use stated by Mettler-Toledo GmbH without consent from Mettler-Toledo GmbH is considered as not intended.

#### Responsibilities of the instrument owner

The instrument owner is the person holding the legal title to the instrument and who uses the instrument or authorizes any person to use it, or the person who is deemed by law to be the operator of the instrument. The instrument owner is responsible for the safety of all users of the instrument and third parties.

METTLER TOLEDO assumes that the instrument owner trains users to safely use the instrument in their workplace and deal with potential hazards. METTLER TOLEDO assumes that the instrument owner provides the necessary protective gear.

#### Safety notes



#### NOTICE

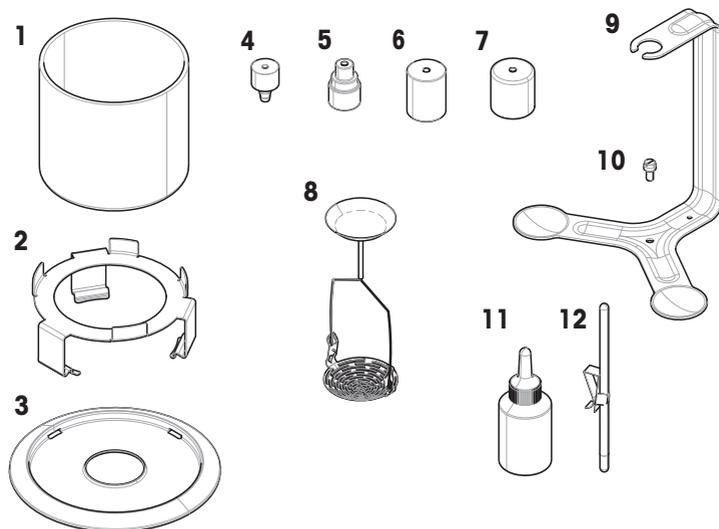
##### Damage to the instrument due to the use of unsuitable parts

Using unsuitable parts with the instrument can damage the instrument or cause it to malfunction.

- Only use parts from METTLER TOLEDO that are intended to be used with your instrument.

### 3 Installation and Putting into Operation

#### 3.1 Scope of delivery



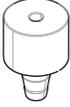
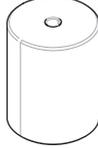
1	Beaker, $\varnothing$ 85 mm, H 75 mm	8	Holder for sinking and floating solids
2	Beaker holder	9	Bracket
3	Draft ring, $\varnothing$ 90 mm	10	Screw
4	Compensation weight, brass, for 0.1 mg and 0.01 mg balances	11	Wetting agent
5	Compensation weight, aluminum, for 0.1 mg balances	12	Thermometer, non-calibrated, with holder
6	Compensation weight, aluminum, for 1 mg balances		Reference manual
7	Compensation weight, brass, for 1 mg balances		

**Note**

For the density determination of liquids, a sinker is used. For the ordering numbers, see [Spare Parts and Accessories ▶ Page 15].

### 3.2 Compatibility table

Find the model, readability, and capacity of your balance on the type plate.

Readability	Balance models	Compensation weight, brass, for 0.1 mg and 0.01 mg balances	Compensation weight, aluminum, for 0.1 mg balances	Compensation weight, aluminum, for 1 mg balances	Compensation weight, brass, for 1 mg balances	Draft ring
						
1 mg	JET1003G JP-G JS-G ML ML-T MS-S MS-TS JE-G JET-G <sup>1)</sup> ME ME-T TLE	–	–	–	✓	to be installed
		–	–	–	✓	not needed
		–	–	✓	–	to be installed
0.1 mg	JET1603C JP-C JS-C ML ML-T MS-S MS-TS	–	✓	–	–	included in balance
0.1 mg / 0.01 mg	JE-C JET-C <sup>2)</sup> ME TLE	✓	–	–	–	included in balance
0.01 mg	MS	✓	–	–	–	included in balance

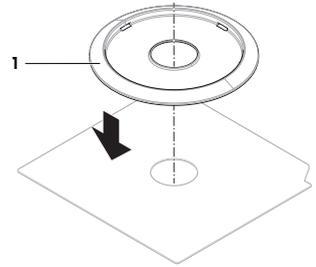
<sup>1)</sup> only for balances with a capacity up to 620 g

<sup>2)</sup> only for balances with a capacity up to 220 g

### 3.3 Installing the density kit

- The proper compensation weight has been determined for the balance type. See [Compatibility table ▶ Page 6]

- 1 Disconnect the balance from the power supply.
- 2 Open the draft shield.
- 3 Remove the weighing pan.
- 4 If the balance does not include a draft ring and needs one, install the one provided with the density kit (1). See [Compatibility table ▶ Page 6]

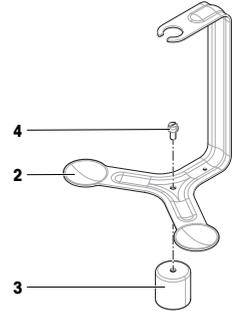


- 5 Assemble the bracket (2) and the appropriate compensation weight (3) with the provided screw (4).

**Note**

Depending on the balance model, the compensation weight in the illustration may look different.

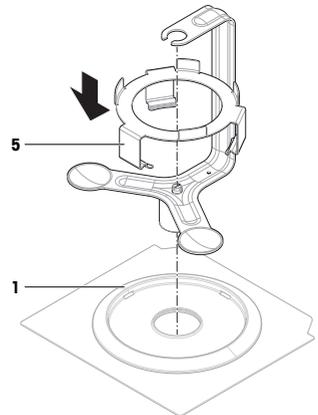
- 6 Install the compensation weight and bracket on the weighing cell.



- 7 Place the beaker holder (5) on the balance (1). Make sure that the widest foot faces the front of the balance; the beaker holder must not be in contact with the bracket.

- 8 Reconnect the balance to the power supply.

⇒ The density kit is ready to be used.



## 4 Operation

This section provides theoretical and practical information about how to determine the density of solids and liquids using the density kit. It also includes recommendations to improve the results' accuracy and precision. Depending on your balance model and software version, the main operation steps and necessary calculations might be implemented in the balance software; follow the instructions from the wizard for support.



For further information, consult the Reference Manual (RM) of your balance.

### 4.1 Principle of density determination

The density  $\rho$  is the quotient of the mass  $m$  and the volume  $V$ .

**Density:**

The international system of units specifies  $\text{kg/m}^3$  as the unit of density. However, the unit  $\text{g/cm}^3$  is better suited to laboratory purposes.

$$\rho = \frac{m}{V}$$

Density determinations are frequently performed by Archimedes' principle, which is also used with this density kit. **Archimedes' principle states that a body immersed partially or fully in fluid experiences a buoyant force acting upwards on it. The magnitude of this force is equivalent to the weight of the fluid displaced by the body.**

The procedure for the density determination by Archimedes' principle depends on whether the density of solids or liquids has to be determined.

### 4.2 Density of solids

#### 4.2.1 Principle of density determination of solids

The density of a solid is determined with the aid of a liquid whose density  $\rho_0$  is known. Water or ethanol are frequently used as auxiliary liquids. The solid is weighed in air (A) and then in the auxiliary liquid (B). The density  $\rho$  can be calculated from the two weighing results.

**Density:**

$$\rho = \frac{A}{A-B} (\rho_0 - \rho_L) + \rho_L$$

**Volume:**

$$V = \alpha \frac{A-B}{\rho_0 - \rho_L}$$

#### Legend

A	Weight of sample in air
B	Weight of sample in the auxiliary liquid
$\rho$	Density of sample
$\rho_0$	Density of auxiliary liquid
$\rho_L$	Density of air (0.0012 g/cm <sup>3</sup> )
$\alpha$	Balance correction factor (0.99985). It takes air buoyancy of the adjustment weight(s) into account.

## 4.2.2 Determining the density of solids



### NOTICE

#### Erroneous results due to improper handling

Parts of the instrument or the sample immersed in liquid should be clean to obtain correct weighing results.

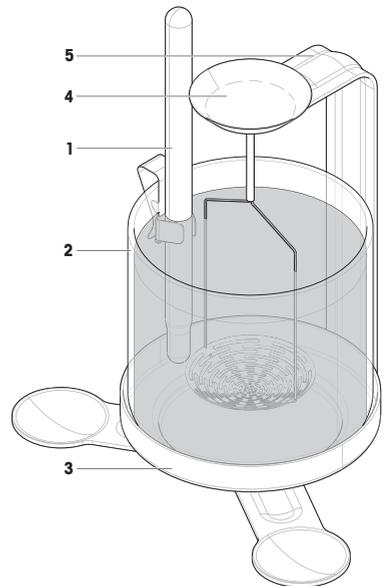
- Always use gloves when touching parts that are immersed in liquid.

To improve the accuracy of the results, take the following precautionary measures:

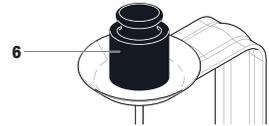
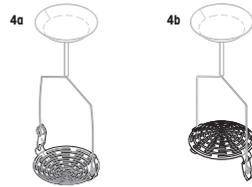
- The effect of temperature on liquids can cause density changes of order of magnitude 0.1 to 1 ‰ per °C. To obtain accurate results, take the temperature of the auxiliary liquid into account in all density determinations.
- Adhesion of the auxiliary liquid to the suspension wires of the basket causes an apparent weight increase of up to 3 mg. If the greatest possible accuracy is required, pour a few drops of the wetting agent in the auxiliary liquid.
- To avoid air bubbles:
  - Use enclosed wetting agent or organic liquids. The density change due to the addition of wetting agent can be neglected.
  - Remove grease traces from solvent-resistant solids.
  - Clean basket at regular intervals.
  - Remove adhering air bubbles with a fine brush.
  - Gently move the basket on first-time immersion to dislodge any air bubbles.

#### Preparing the density kit

- The draft shield doors are closed (if applicable).
- 1 Tap **→0←** to zero the balance.
  - 2 Open the draft shield.
  - 3 Attach the supplied thermometer (1) to the beaker (2) and place the beaker on the pan (3).
  - 4 Fill the beaker with the auxiliary liquid. Add enough liquid to ensure that the solid is covered by at least 1 cm of liquid after immersion.

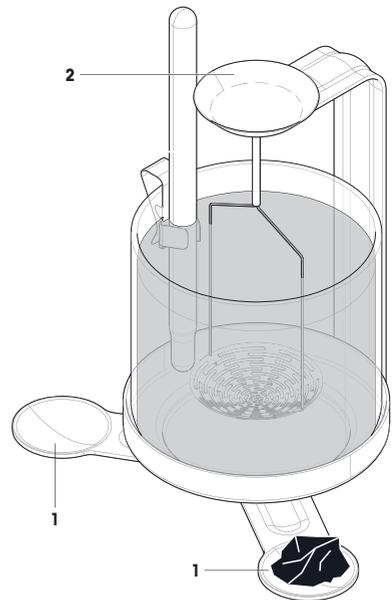


- 5 Carefully rotate the basket section of the holder to the appropriate configuration: for sinking (4a) or floating (4b) solids.
- 6 Hang the holder (4) to the bracket (5). Make sure that no air bubbles adhere to the immersed part of the holder. Remove air bubbles by either moving the holder or by using a fine brush.
- 7 For floating solids: If the buoyancy of the solid is greater than the weight of the holder, the holder must be weighted by placing an additional weight (6) on the top weighing pan of the holder. This additional weight must remain on top of the weighing pan during the entire procedure.
- 8 Close the draft shield.
- 9 Tap →T← to tare the balance.



### Weighing the sample in air

- 1 Open the draft shield.
- 2 Place the sample on one of the two weighing pans (1) of the bracket or, if the weight of the sample is > 20 g, in the pan at the top of the holder (2).
- 3 Wait until the balance has reached stability and note the displayed value (corresponding to "A" in the formula).
- 4 Open the draft shield.
- 5 Remove the sample from the pan.

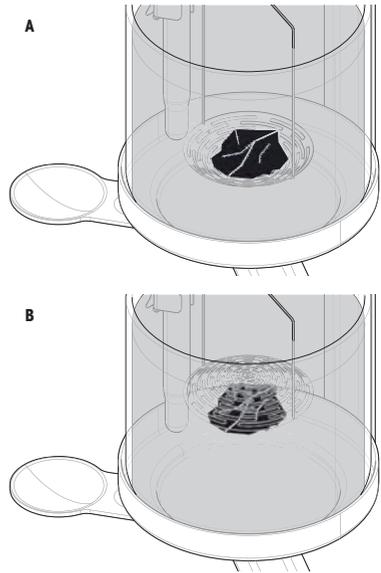


### Weighing the sample in liquid

- 1 For sinking solids, place the sample in the holder's basket (A). For floating solids, place the sample under the holder's basket (B).
- 2 Ensure that no air bubbles adhere to the sample. Remove any air bubbles with a fine brush.
- 3 Close the draft shield.
- 4 Wait until the balance has reached stability and note the displayed value (corresponding to "B" in the formula).
- 5 Determine the density  $\rho$  of the solid according to the corresponding formula.

### See also

- ▣ Principle of density determination of solids ▶ Page 8



## 4.3 Density of liquids

### 4.3.1 Principle of density determination of liquids

The density of a liquid is determined using a sinker of known volume. The sinker is weighed in air and then in the liquid whose density is to be determined. The density  $\rho$  can be determined from the two weighing results.

With an electronic balance, it is possible to determine the weight of the displaced liquid  $P$  ( $P = A - B$ ), and thus the buoyancy, leading to a simplified formula.

#### Density:

$$\rho = \alpha \frac{A-B}{V} + \rho_L$$

#### Density simplified:

$$\rho = \alpha \frac{P}{V} + \rho_L$$

### Legend

A	Weight of sinker in air
B	Weight of sinker in the liquid
P	Weight of displaced liquid ( $P = A - B$ )
V	Volume of sinker
$\rho$	Density of liquid
$\rho_L$	Density of air (0.0012 g/cm <sup>3</sup> )
$\alpha$	Balance correction factor (0.99985). It takes air buoyancy of the adjustment weight(s) into account.

### 4.3.2 Determining the density of liquids



#### NOTICE

##### Erroneous results due to improper handling

Parts of the instrument or the sample immersed in liquid should be clean to obtain correct weighing results.

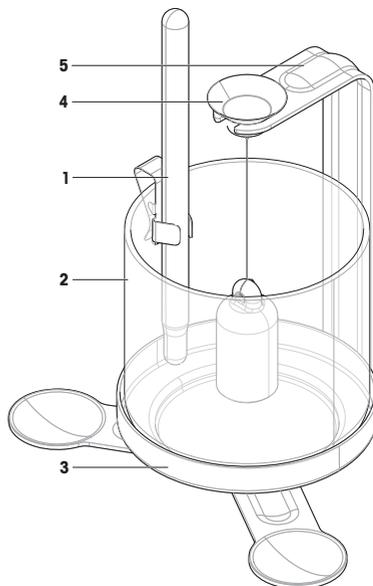
- Always use gloves when touching parts that are immersed in liquid.

To avoid air bubbles, take the following precautionary measures:

- Use enclosed wetting agent or organic liquids. The density change due to the addition of wetting agent can be neglected.
- Remove grease traces from solvent-resistant solids.
- Clean sinker at regular intervals.
- Gently move sinker on first-time immersion to dislodge any air bubbles.
- Remove adhering air bubbles with a fine brush.

#### Preparing the density kit

- The sinker is available.
  - The draft shield doors are closed (if applicable).
- 1 Tap **→0←** to zero the balance.
  - 2 Open the draft shield.
  - 3 Attach the supplied thermometer (1) to the beaker (2) and place the beaker on the pan (3).
  - 4 Hook the sinker (4) to the bracket (5) and ensure that it does not touch either the beaker or the thermometer.
  - 5 Close the draft shield.
  - 6 Tap **→T←** to tare the balance.

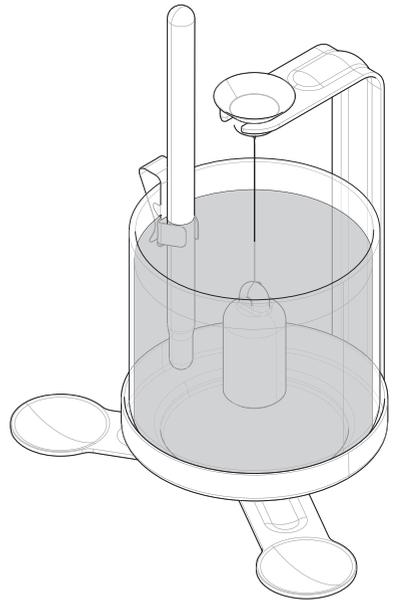


### Weighing the sinker in liquid

- 1 Open the draft shield.
- 2 Fill the beaker with the liquid whose density you want to determine. Add enough liquid to ensure that the sinker is covered by at least 1 cm of liquid after immersion.
- 3 Ensure that no air bubbles adhere to the immersed part of the sinker. Remove air bubbles by either moving the sinker or by using a fine brush.
- 4 Close the draft shield.
- 5 Wait until the balance has reached stability and note the displayed value (corresponding to "P" in the formula).
- 6 Determine the density  $\rho$  of the liquid at the temperature indicated by the thermometer according to the corresponding formula.

### See also

- ▣ Principle of density determination of liquids ▶ Page 11



## 5 Technical Data

### 5.1 Wires

	Wire of holder	Wire of sinker 10 ml
Material	Stainless steel	Platinum
Diameter	0.6 mm	0.2 mm

### 5.2 Sinkers 10 ml

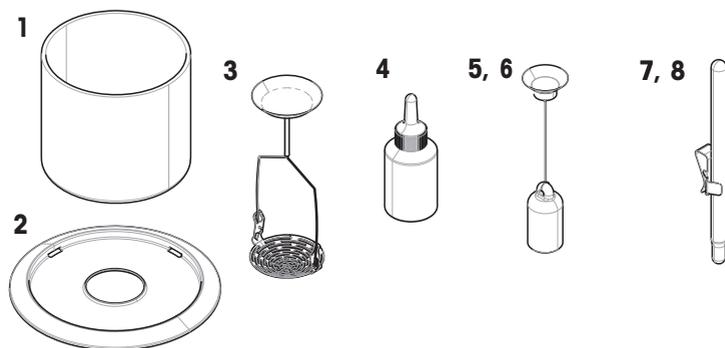
- The nominal volume of the sinker is 10.00 cm<sup>3</sup> with a tolerance of  $\pm 0.5\%$ .
- The calibrated volume of the sinker is available in the calibration certificate (measurement uncertainty of  $\pm 0.05\%$ ).
- Using the nominal volume of the sinker, i.e., 10.00 cm<sup>3</sup>, for the density determination of water at a temperature of 20 °C leads to a maximum error of  $\pm 0.5\%$ , i.e.,  $\pm 0.005$  g/cm<sup>3</sup>.
- Using the calibrated volume of the sinker for the density calculation contributes to the uncertainty of the density value by  $\pm 0.05\%$ .
- When the sinker is immersed under 10 mm of liquid, the additional immersed volume of wire is 0.001 cm<sup>3</sup>.

### 5.3 Density of distilled water

T/ °C	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
10	0.99970	0.99969	0.99968	0.99967	0.99966	0.99965	0.99964	0.99963	0.99962	0.99961
11	0.99960	0.99959	0.99958	0.99957	0.99956	0.99955	0.99954	0.99953	0.99952	0.99951
12	0.99950	0.99949	0.99947	0.99946	0.99945	0.99944	0.99943	0.99941	0.99940	0.99939
13	0.99938	0.99936	0.99935	0.99934	0.99933	0.99931	0.99930	0.99929	0.99927	0.99926
14	0.99924	0.99923	0.99922	0.99920	0.99919	0.99917	0.99916	0.99914	0.99913	0.99911
15	0.99910	0.99908	0.99907	0.99905	0.99904	0.99902	0.99901	0.99899	0.99897	0.99896
16	0.99894	0.99893	0.99891	0.99889	0.99888	0.99886	0.99884	0.99883	0.99881	0.99879
17	0.99877	0.99876	0.99874	0.99872	0.99870	0.99869	0.99867	0.99865	0.99863	0.99861
18	0.99859	0.99858	0.99856	0.99854	0.99852	0.99850	0.99848	0.99846	0.99844	0.99842
19	0.99840	0.99838	0.99836	0.99835	0.99833	0.99831	0.99828	0.99826	0.99824	0.99822
20	0.99820	0.99818	0.99816	0.99814	0.99812	0.99810	0.99808	0.99806	0.99803	0.99801
21	0.99799	0.99797	0.99795	0.99793	0.99790	0.99788	0.99786	0.99784	0.99781	0.99779
22	0.99777	0.99775	0.99772	0.99770	0.99768	0.99765	0.99763	0.99761	0.99758	0.99756
23	0.99754	0.99751	0.99749	0.99747	0.99744	0.99742	0.99739	0.99737	0.99734	0.99732
24	0.99730	0.99727	0.99725	0.99722	0.99720	0.99717	0.99715	0.99712	0.99709	0.99707
25	0.99704	0.99702	0.99699	0.99697	0.99694	0.99691	0.99689	0.99686	0.99684	0.99681
26	0.99678	0.99676	0.99673	0.99670	0.99667	0.99665	0.99662	0.99659	0.99657	0.99654
27	0.99651	0.99648	0.99646	0.99643	0.99640	0.99637	0.99634	0.99632	0.99629	0.99626
28	0.99623	0.99620	0.99617	0.99615	0.99612	0.99609	0.99606	0.99603	0.99600	0.99597
29	0.99594	0.99591	0.99588	0.99585	0.99582	0.99579	0.99577	0.99574	0.99571	0.99568
30	0.99564	0.99561	0.99558	0.99555	0.99552	0.99549	0.99546	0.99543	0.99540	0.99537

ISO 15212-1:1998 Oscillation-type density meters – Part 1: Laboratory instruments

## 6 Spare Parts and Accessories



	Order no.	Designation	Remarks
<b>1</b>	30528711	Beaker, $\varnothing$ 85 mm, H 75 mm	–
<b>2</b>	12122043	Draft protection ring	For weighing pan $\varnothing$ 90 mm
<b>3</b>	30004211	Holder for sinking and floating solids	–
<b>4</b>	72409	Wetting agent	–
<b>5</b>	210260	Sinker 10 ml, non-calibrated	–
<b>6</b>	210672	Sinker 10 ml, calibrated	–
<b>7</b>	238767	Thermometer, non-calibrated	Including: holder
<b>8</b>	11132685	Thermometer, calibrated	Including: holder





# GWP®

Good Weighing Practice™

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GWP® is the global weighing standard, ensuring consistent accuracy of weighing processes, applicable to all equipment from any manufacturer. It helps to:

- Choose the appropriate balance or scale
- Calibrate and operate your weighing equipment with security
- Comply with quality and compliance standards in laboratory and manufacturing

 [www.mt.com/GWP](http://www.mt.com/GWP)

[www.mt.com/lab-accessories](http://www.mt.com/lab-accessories)

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