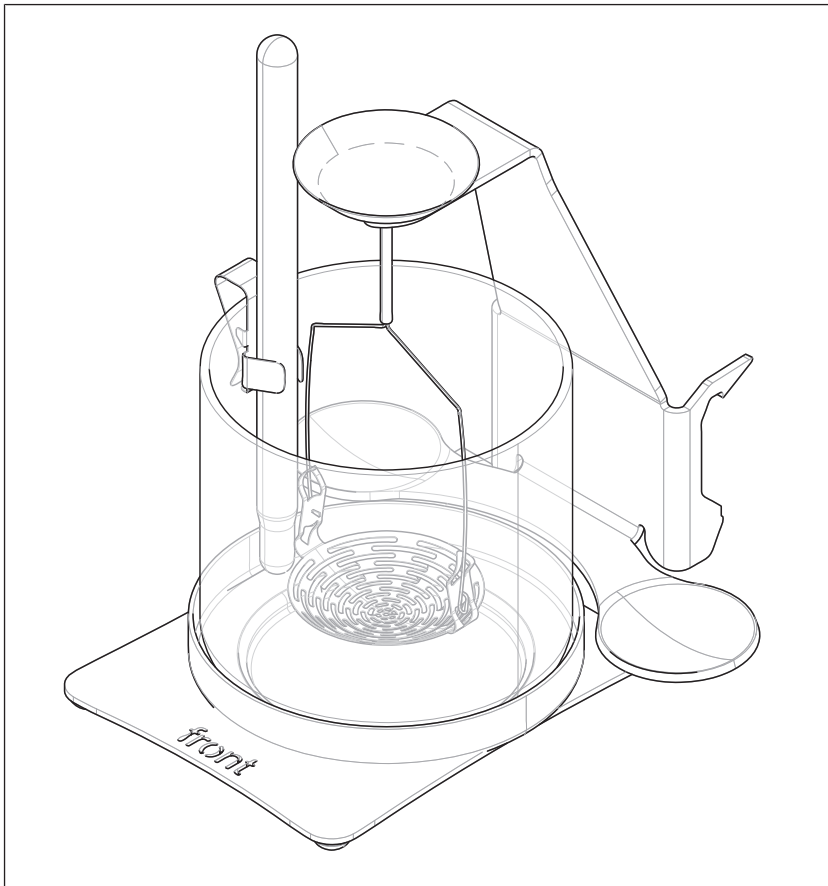


# Density Kit for Analytical Balances

XPR, XPR Essential



**METTLER TOLEDO**





This Reference Manual provides information to handle the instrument in a safe and efficient manner. Personnel must have carefully read and understood this manual before performing any tasks.

This document is available in other languages online.

► [www.mt.com/Density-Kit-analytical-RM](http://www.mt.com/Density-Kit-analytical-RM)

## 1 Introduction

Thank you for choosing a METTLER TOLEDO density kit.

The density kit allows you to determine the density of solids and liquids.

### Purpose of this document


This document explains how to work with the density kit. It provides the procedure for performing a density determination manually as well as instructions on the **density determination software**. If you need information on operating your balance, please refer to the "Reference Manual (RM)" of your balance.

### Finding more information

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

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

### Conventions and symbols

Key and/or button designations and display texts are shown in graphic or bold text, e.g., , **Edit**.



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

## 2 Safety Information

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

### 2.1 Definition of signal words and warning symbols

Safety notes are marked with signal words and warning symbols. These show safety issues and warnings. Ignoring the safety notes may lead to personal injury, damage to the instrument, malfunctions and false results.

#### Signal words

**NOTICE** 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

#### Personal protective equipment



Wear gloves to avoid contamination.

### 2.2 Product-specific safety information

#### Intended use

Your density kit is used to determine the density of solids and liquids. Use the density kit exclusively for this purpose. Any other type of use and operation beyond the limits of technical specifications without written consent from Mettler-Toledo GmbH is considered as not intended.

Intended use also includes compliance with all the instruction in this "Reference Manual" and the "Reference Manual" of your balance.

#### 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 GmbH assumes that the instrument owner trains users to safely use the instrument in their workplace and deal with potential hazards. Mettler-Toledo GmbH assumes that the instrument owner provides the necessary protective gear.

#### Safety notes



#### NOTICE

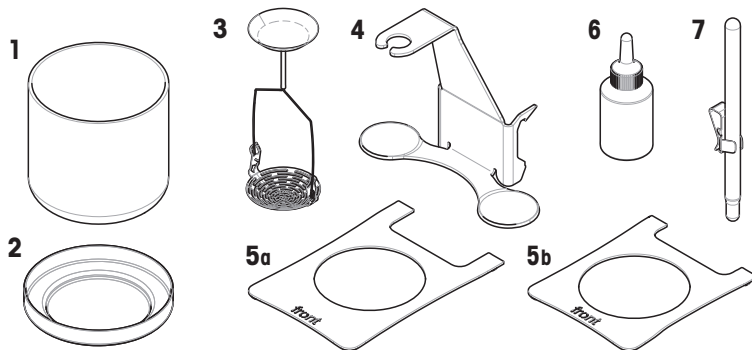
##### Damage or malfunction due to the use of wrong parts

Through the use of the wrong or defective parts, dangers for personnel can occur and damage, malfunction or total instrument failure can occur.

- Use only original parts supplied or approved by the manufacturer.

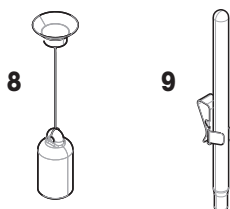
### 3 Installation and Putting into Operation

#### 3.1 Scope of delivery



No.	Designation	No.	Designation
1	Glass beaker $\varnothing$ 80 mm, high	5a	Support plate for XPR
2	Pan	5b	Support plate for XPR Essential
3	Holder for sinking and floating solids	6	Wetting agent
4	Bracket	7	Precision thermometer with holder

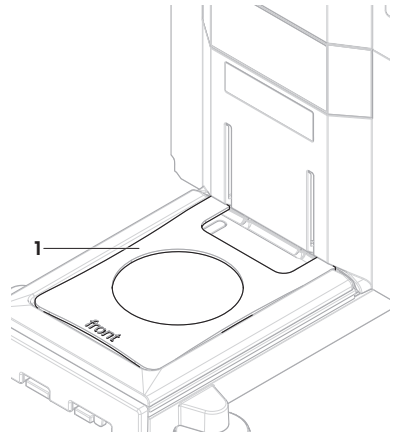
#### 3.2 Accessories



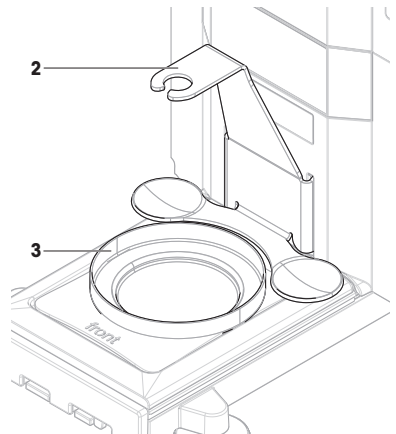
No.	Designation	No.	Designation
8	Sinker 10 ml	9	Precision thermometer, calibrated
	Sinker 10 ml, calibrated		

### 3.3 Installing the density kit


- 1 Remove the weighing pan from the weighing chamber.
- 2 Insert the support plate (1).



- 3 Hang the bracket (2) on the pan suspension.
  - 4 Insert the pan (3) into the support plate.
- ➔ To operate the density kit, refer to the section "Operation".



## 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. The main operation steps and necessary calculations are implemented in the balance software; follow the instructions from the wizard for support (method  **Density determination**).



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

[www.mt.com/XPR-analytical-RM](http://www.mt.com/XPR-analytical-RM)

### 4.1 Principle of density determination

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

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.

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.

**Density:**

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

### 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 usually 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> )
V	Volume of sample
$\alpha$	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

The sample and the parts of the instrument immersed in liquid should be clean to obtain correct weighing results.

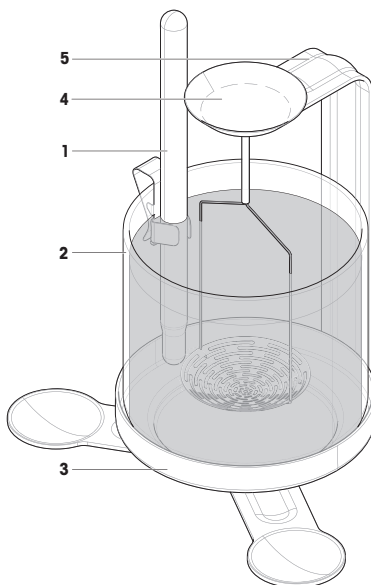
- Always use gloves when touching parts that are immersed in liquid.

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

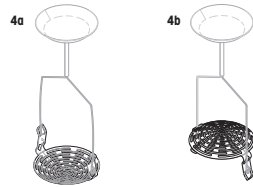
- The effect of temperature on liquids can cause density changes of order of magnitude 0.1 to 1 ‰ per °C. To obtain accurate results, take the temperature of the auxiliary liquid into account in all density determinations.
- Adhesion of the auxiliary liquid to the suspension wires of the basket causes 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

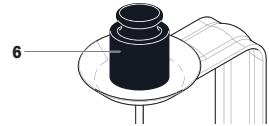
- A density determination method for solids exists.
  - The draft shield doors are closed.
- 1 Press → **0** ← to zero the balance.
  - 2 In the **Methods** window, select a method for the density determination of solids.
  - 3 If required, fill in the relevant sample information, e.g., **Sample ID** and/or **Task ID**.
  - 4 Tap ► **Start method**.
  - 5 Attach the supplied thermometer (1) to the beaker (2).
  - 6 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.
  - 7 Read the temperature from the thermometer and insert the value in the corresponding field.
  - 8 If you are not using distilled water as auxiliary liquid, choose **Custom** from the list and fill in the auxiliary liquid parameters.
  - 9 Tap ✓ **OK**.
  - 10 Open the draft shield.
  - 11 Place the beaker (2) on the pan (3).



- 12 Carefully rotate the basket of the holder to the appropriate configuration: for sinking solids (4a) or floating (4b) solids.
- 13 Hang the holder (4) on the bracket (5). Make sure that no air bubbles adhere to the immersed part of the holder. Remove air bubbles either by moving the holder or by using a fine brush.



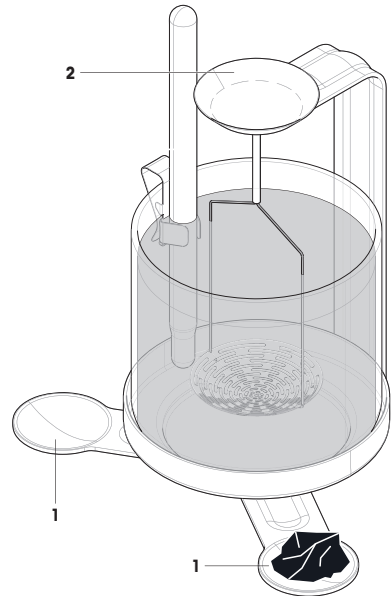
- 14 For floating solids: If the buoyancy of the solid is greater than the weight of the holder, the holder must be weighted by placing an additional weight (6) on the top weighing pan of the holder. This additional weight must remain on top of the weighing pan during the entire procedure.



- 15 Close the draft shield.
- 16 Tap **✓ OK**.
  - ➔ The density kit is installed and the balance is tared.

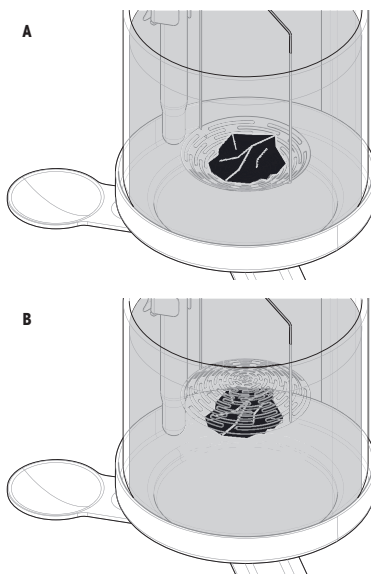
### Weighing the sample in air

- 1 Open the draft shield.
- 2 Place the sample on one of the two weighing pans (1) of the bracket. If the weight of the sample is > 20 g, place it on the weighing pan at the top of the holder (2).
- 3 Close the draft shield.
- 4 Tap **✓ OK**.
  - ➔ The weight of the sample in air is recorded, corresponding to "A" in the formula of the density determination of solids.



### Weighing the sample in liquid

- 1 Open the draft shield.
- 2 Remove the sample from the weighing pan.
- 3 For sinking solids, place the sample in the holder's basket (A). For floating solids, place the sample under the holder's basket (B).
- 4 Ensure that no air bubbles adhere to the sample. Remove any air bubbles with a fine brush.
- 5 Close the draft shield.
- 6 Tap **✓ OK**.
  - ➔ The weight of the sample in liquid is recorded, corresponding to "B" in the formula for the density determination of solids.
  - ➔ The density is calculated and added to the **Results list**.
- 7 To view the detailed results, open the **Results list** and select the relevant entry.



### 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

The sample and the parts of the instrument immersed in liquid should be clean to obtain correct weighing results.

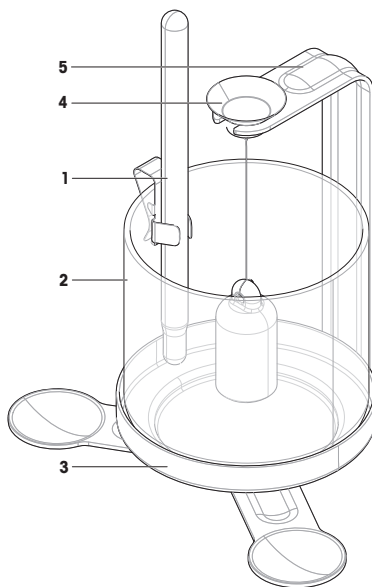
- Always use gloves when touching parts that are immersed in liquid.

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.

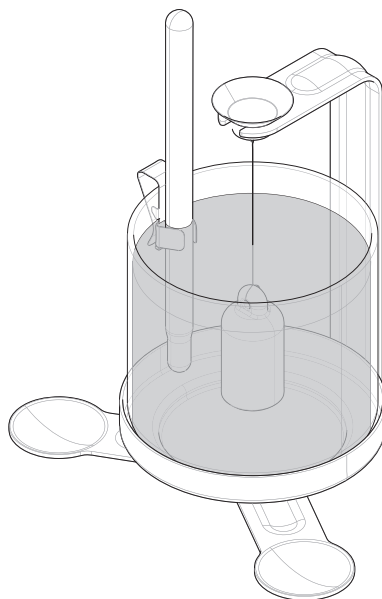
## Preparing the density kit

- A density determination method for liquids (sinker) exists.
  - The sinker is available.
  - The draft shield doors are closed.
- 1 Press **→0←** to zero the balance.
  - 2 In the **Methods** window, select a method for the density determination of liquids (sinker) and fill in the relevant sample information.
  - 3 If required, fill in the relevant sample information, e.g., **Sample ID** and/or **Task ID**.
  - 4 Tap **▶ Start method**.
  - 5 Fill in the temperature of the liquid and the volume of the sinker.
  - 6 Attach the supplied thermometer (1) to the beaker (2).
  - 7 Place the beaker (2) on the pan (3).
  - 8 Hang the sinker (4) on the bracket (5) and ensure that it does not touch either the beaker or the thermometer.
  - 9 Close the draft shield.
  - 10 Tap **✓ OK**.
- ➔ The balance is tared. The icon **Net** appears.



## 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 Tap **✓ OK**.
  - ➔ The weight difference is recorded, corresponding to "P" in the formula for the density determination of liquids.
  - ➔ The density is calculated and added to the **Results list**.
- 6 To view the detailed results, open the **Results list** and select the relevant entry.



**See also**

[🔗](#) Principle of density determination of liquids ▶ Page 12

## 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 Sinker 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>.

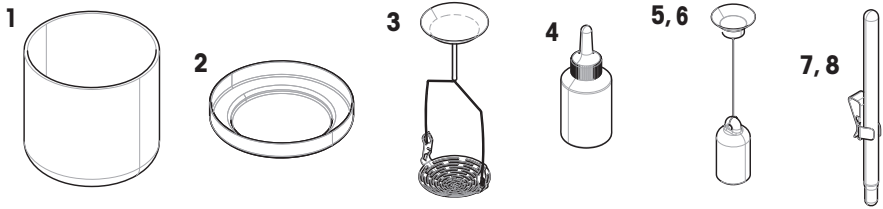
### 5.3 Density of distilled water

The density of distilled water implemented in the density determination method is based on the ISO 15212 standard and can be found below.

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>	11142289	Glass beaker $\varnothing$ 80 mm, high	–
<b>2</b>	238164	Pan	–
<b>3</b>	30004746	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









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