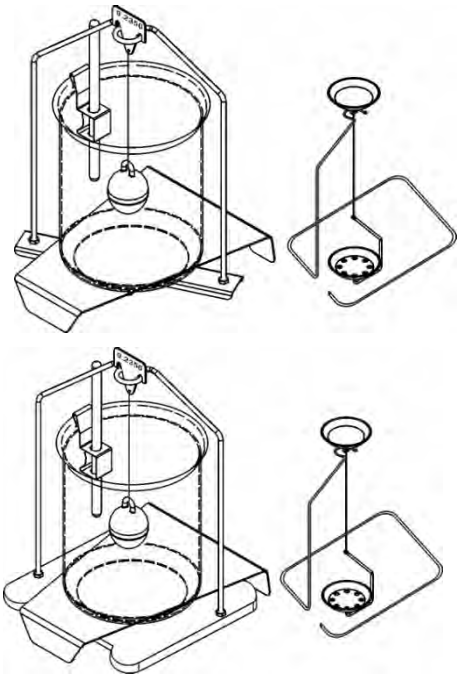
User Manual

User manual no.:
LMI-46-03/04/13/A

DENSITY DETERMINATION KIT FOR SOLIDS AND LIQUIDS

- for XA series
- for PS series
- for AS series



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APRIL 2013

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1. INTRODUCTION

Determining density of solids and liquids is an indispensable process in majority of laboratories. Considering this fact, RADWAG company prepared software which improves process of density measurement.

Traditional method of density measurement requires an operator to carry out laborious measurement and toilsome measurements. In effect the result of density measurement can be burdened with set of calculation and statistical errors, while time required to determine density of solids or liquids or rather long.

In case of applying balances with function of density measurement of solids or liquids, the procedure can be simplified and quickened. Time which user needs to receive final result is short because all calculations are performed by balance's software. User activity is limited to manual processes, such as:

- Operation of balance's keyboard
- Loading a sample onto weighing pans
- Hanging a sinker.

The density of solids and liquids can be determined using a dedicated measuring kit. It is part of the additional equipment of laboratory balances. The density measuring software offers the following highlights:

- simplicity of operation (all activities are presented on the display to a user),
- reliability (all calculations are carried out by the software automatically),
- fast data processing (user receives the result after determining sample mass in liquid or sinker in the liquid),
- reliable data processing (before each measurement the indication is set to zero. Thus, measurement results are reliable and indicate actual mass),
- printing results on any printer or sending them to a computer for further processing.

2. PRINCIPLE OF DENSITY MEASUREMENT

2.1. DEFINITIONS

- **Density**

  Density refers to a ratio between sample mass and its volume.

$$\rho = \frac{M}{V} \quad [g/cm^3]$$

  ρ - sample density
  M - sample mass
  V - sample volume

- **Relative gravity**

  Relative gravity refers to the ratio of sample density to the density of pure water (with the same volume as that of the sample) at 4°C, and at pressure 1013,25 hPa.

$$S = \frac{M}{V \times \rho_n}$$

  S - relative gravity
  M - sample mass
  V - volume
  ρ_n - density of water at 4°C, at pressure 1013,25 hPa

- **Archimedes' Principle**

  A body immersed in a liquid undergoes an apparent loss in weight equal to the weight of the fluid it displaces.

- **Density of solid**

  The density of solid can be obtained using the following formula:

$$\rho = \frac{A}{A - B}\rho_o$$

  ρ - sample density
  A - sample mass in the air
  B - sample mass in liquid
  ρ_o - density of liquid

- **Density of liquid**
  The density of liquid can be obtained using the following formula:

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

ρ - density of liquid
A - sinker mass in the air
B - sinker mass in liquid
V - sinker's volume
d - density of air (max 0,001 g/cm^3)

2.2. SOURCE OF MEASUREMENT ERRORS

The software of balances calculates and indicates on balance's digital display the result of density measurement with the accuracy of 0,001 g/cm^3. Bear in mind that the measurement result can be burdened with additional errors.

- **Error of mass measurement**

  Sample mass (in the air and in the water) is obtained using a balance with accuracy 0,001g.

- **Air Buoyancy**

  The air buoyancy is determined using a formula:

$$d = \frac{0{,}0012932}{1 + 0{,}0036728 \times t} \times \frac{p}{1013{,}25}$$

t - air temperature [°C]
p - air pressure

- **Liquid temperature**

  When determining density of solids, the density of liquid in which the measurement is carried out changes according to its temperature.
  The density of liquid (H_2O and C_2H_5OH) is accepted by the software in accordance with tables stored in balance's

processor, and depending on temperature of liquid directly before the measurement.
Density of other liquid is inserted to balance's memory by a user before density measurement.

Caution:
Corrections of density of distilled water and alcohol are noted by the balance software automatically.

- **Sinker volume**

  It is given on sinker's hanger and it is expressed in cm^3.

- **Surface tension**

  During density measurement of a solid the weighing pan is subject to a force (surface tension) which interacts between pan's wire and liquid surface.
  During density measurement the wire with 0,2 mm in diameter creates a force of approximately 1 mg. The force practically does not influence the measurement result.

- **Air bubbles**

  The buoyancy of an air bubble of 1 mm in diameter is about 0,5 mg.
  Tack of air bubbles depends on the sample's shape and type of material. Air bubbles much easier tack to surfaces covered with grease/oil.

3. MANUFACTURER'S RECOMMENDATIONS

1. *Density of solids should be determined on basis of a few measurements*
2. *Tested sample has to be degreased.*
3. *In case of objects with oval shape, which are difficult to hold using tweezers, cut a notch for secure grasp of the sample.*
4. *Sample surface must not be porous. It creates favourable conditions for sticking of air bubbles.*
5. *Before each following density measurement dry a sample. Unless the sample is dried, it may effect in its different mass while weighing in the air, and density determination result is*

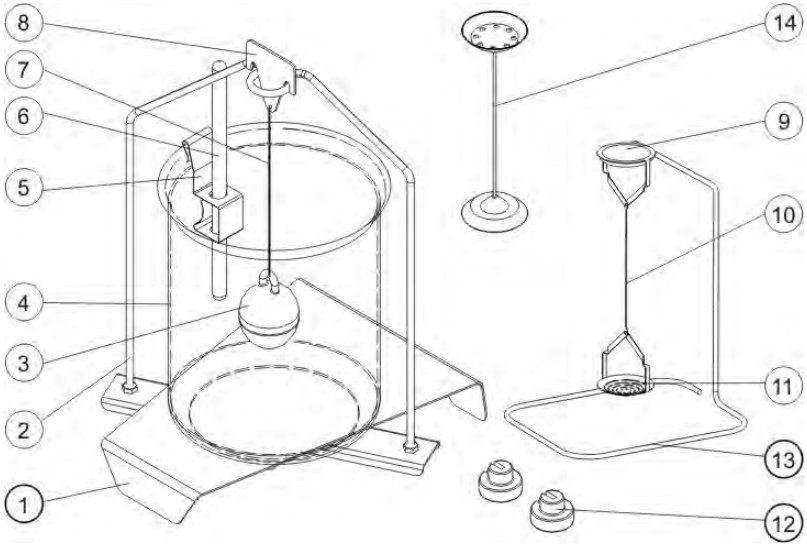
burdened with an error.

6. *Tested material should be loaded gently on density kit's pans, avoiding shocks.*
7. *Liquid level has to be fixed at a level that the arm of the lower weighing pan is fully immersed in the liquid.*
8. *Sample size should match the size of the density kit's weighing pans.*
9. *Mass of a sample used for testing should not exceed 5 g.*
10. *Water remaining on the tweezers while carrying a sample onto the upper pan of the density kit may be a factor disturbing the measurements. Therefore after removing the sample from liquid remember to dry the tweezers.*
11. *Liquid density should be determined on basis of a few measurements.*
12. *Tested liquid should be stabilized for its temperature.*
13. *The sinker has to be degreased. It its surface is covered with grease it may easily tack air bubbles.*
14. *Before measurement carefully wash the beaker.*
15. *Liquid level should be fixed at a level that ensures sinker's immersion by 10-15 mm below liquid surface.*
16. *Hang the sinker on the hanger gently, avoiding shocks.*
17. *Tested liquid may be a factor disturbing the measurement as it tacks to the sinker. In such case sinker's mass measured in the air may differ in the following measuring processes. Therefore dry the sinker after each weighing in liquid.*

Caution:

- *Avoid drying the sinker using cloths made of plastics, as they may create electrostatic charges. It is recommended to dampen the cloth using antistatic liquid or antistatic foam.*
- *Damage of the glass sinker produced during the operation (breaks, bruises) are not repaired under warranty.*

4. DENSITY DETERMINATION KIT FOR SOLIDS AND LIQUIDS – DEDICATED FOR BALANCES XA, AS SERIES



Draw 1. Components of the KIT for balances XA, AS series

Components of the density kit:

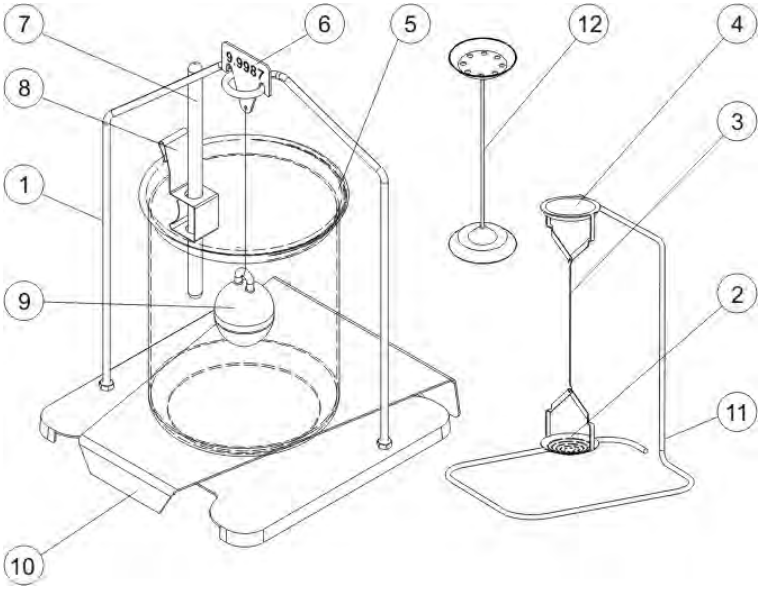
1	Beaker basis	**8**	Hook
2	Stand for weighing pans	**9**	Top weighing pan of density determining kit for solids
3	Sinker	**10**	Pans flexible connector
4	Beaker	**11**	Bottom weighing pan of density determining kit for solids
5	Thermometer handle	**12**	Supplementary weight
6	Thermometer	**13**	Additional stand for set of pans or a sinker
7	Sinker's flexible connector	**14**	Additional set of pans for determining density of solids, which density is lower than density of water.

***Caution**:*

- *Density kit components should be stored in its intended box.*
- *Do not leave the pans of the density kit nor the sinker on tabletop, as it may damage the density kit components.*

- *Unless the set of pans or the sinker are in use, they should be placed on an additional stand.*

5. DENSITY DETERMINATION KIT FOR SOLIDS AND LIQUIDS – DEDICATED FOR BALANCES PS SERIES



Draw 2. Components of the KIT for analytical balances

Components of the density kit:

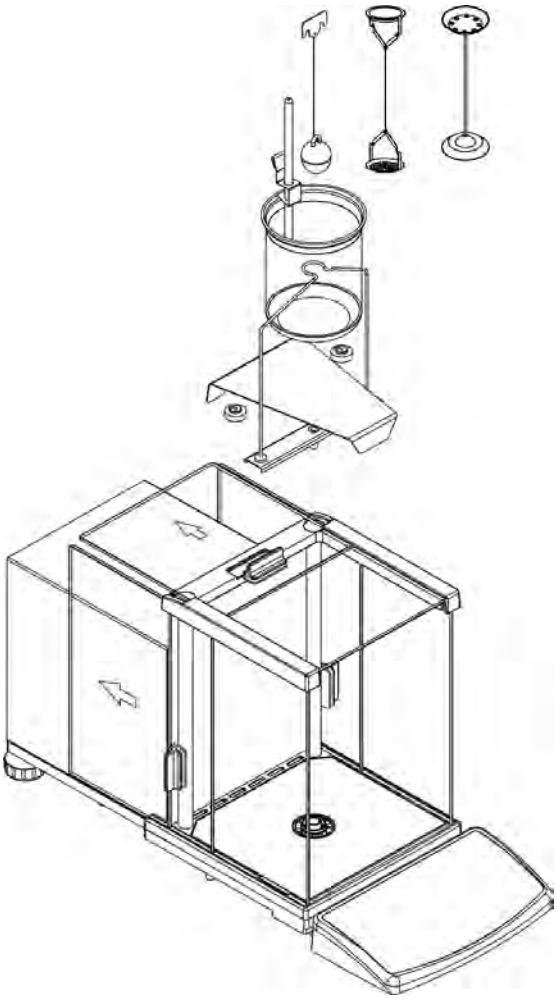
1	Weighing pan with stand	**7**	Thermometer
2	Bottom weighing pan of density determining kit for solids	**8**	Thermometer handle
3	Flexible connector	**9**	Sinker
4	Top weighing pan of density determining kit for solids	**10**	Beaker basis
5	Beaker	**11**	Additional stand for set of pans or a sinker
6	Hook	**12**	Additional set of pans for determining density of solids, which density is lower than density of water.

***Caution**:*

- *Density kit components should be stored in its intended box.*

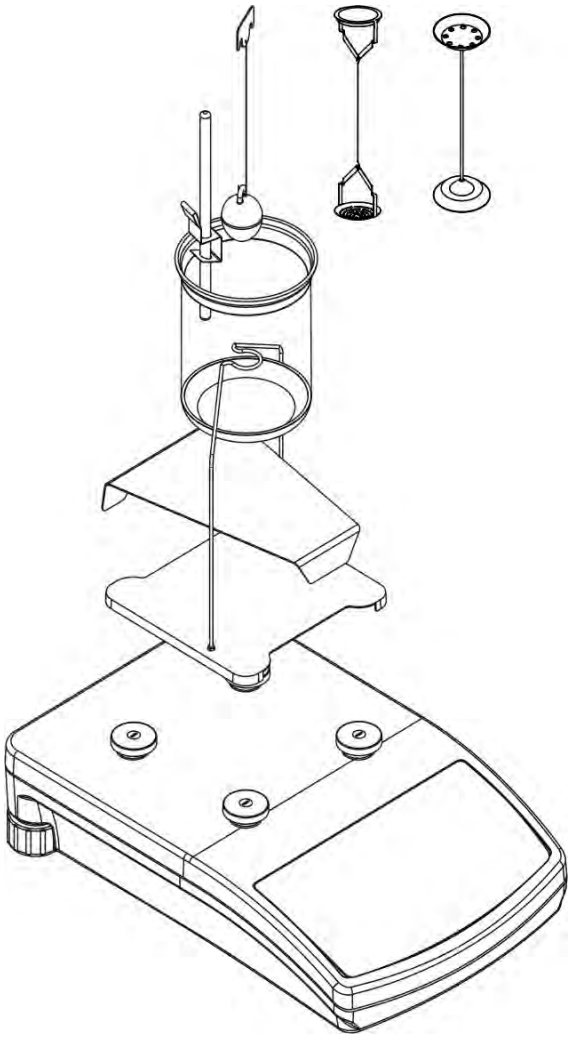
- *Do not leave the pans of the density kit nor the sinker on tabletop, as it may damage the density kit components.*
- *Unless the set of pans or the sinker are in use, they should be placed on an additional stand.*

6. ASSEMBLING THE DENSITY KIT ON BALANCE XA SERIES

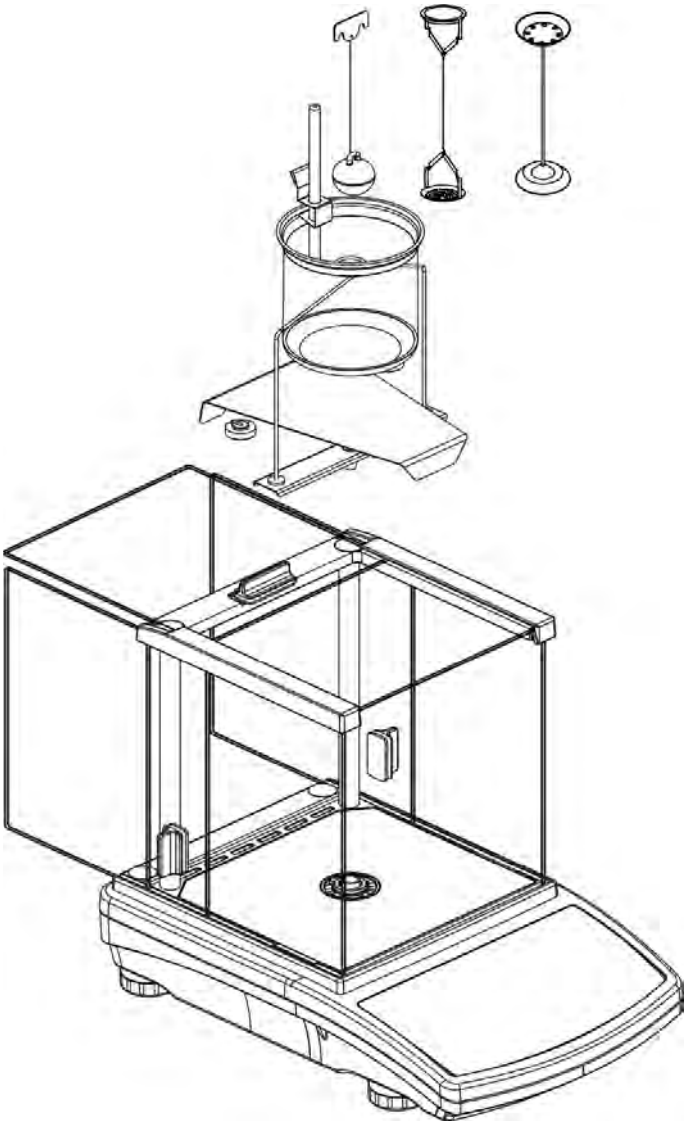


7. ASSEMBLING THE DENSITY KIT

7.1 ON BALANCES PS SERIES



7.2 ON BALANCES AS SERIES



8. DENSITY MEASUREMENT PROCESS IN BALANCES XA/X SERIES

8.1. DENSITY FUNCTION IN BALANCE MENU

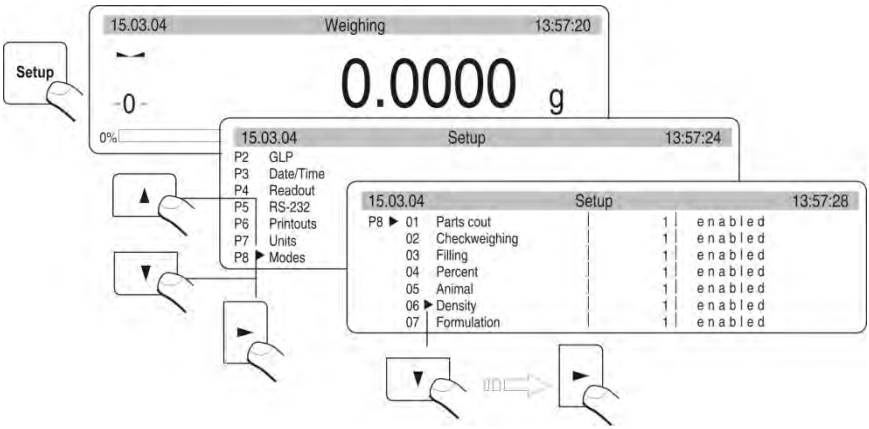


Fig 1. Balance menu – density mode

The density mode should be set to value 1 (enabled). In such case the density determining mode is available through pressing MODE key on balance's overlay.

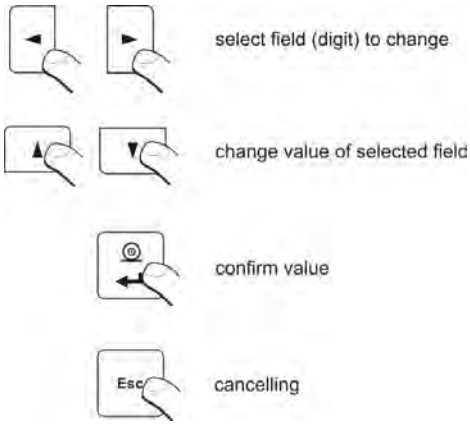


Fig 2. Function key on balance's keyboard

On assembling the density determination kit it is not possible to adjust the balance correctly. Therefore adjust the balance before assembling the density kit.

8.2 DENSITY MODE ACTIVATING

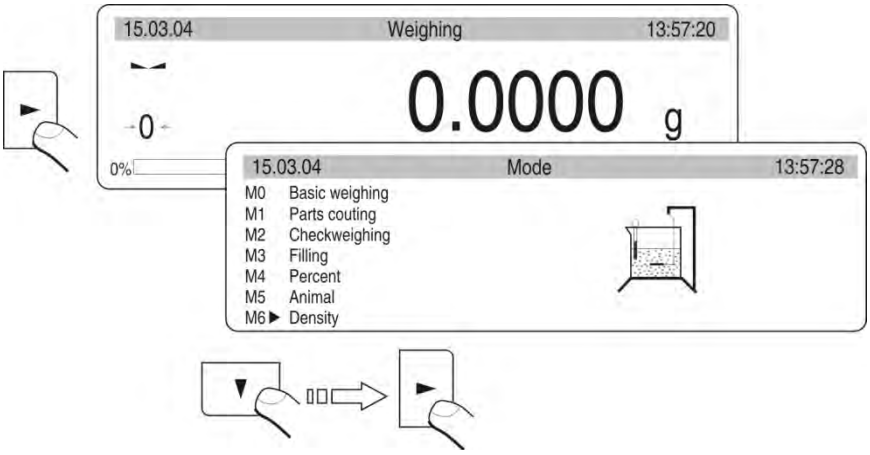


Fig 3. Activating density mode

8.3 DENSITY OF SOLIDS – MENU PREVIEW

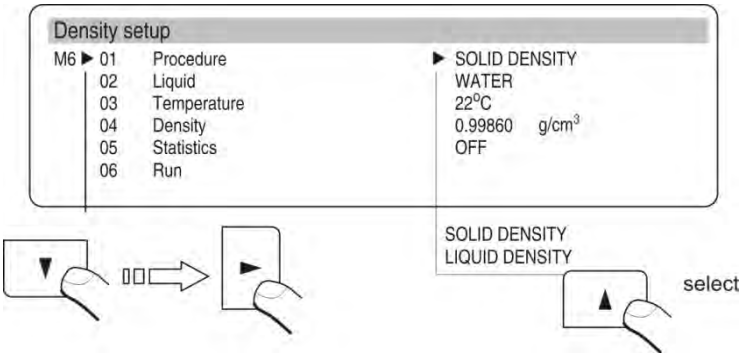


Fig 4. Density of solids – menu preview

Procedure
Select mode of density determination of solids and liquids from balance's menu.

Liquid
Select liquid in which the density determination process is carried out: distilled water, - alcohol (spirit 100% +/- 0.1% at 20^0C), other liquid with known density.

Temperature
Temperature value which should be given by reading it from kit's thermometer. The temperature value is a parameter included in calculation of density value. For option OTHER give medium value of density.

Density
Density of liquid depends on the temperature. For WATER and ALCOHOL the density value is acquired from density value tables stored in balance's memory. On inserting liquid temperature (read from the thermometer) the density value is calculated automatically. For option OTHER write the density of liquid.

Statistics
Statistics are calculated for the following density measurements, if option STATISTICS is enabled (set to: YES) in mode's options.

Run
Start the procedure.

8.4 DENSITY OF LIQUID – MENU PREVIEW

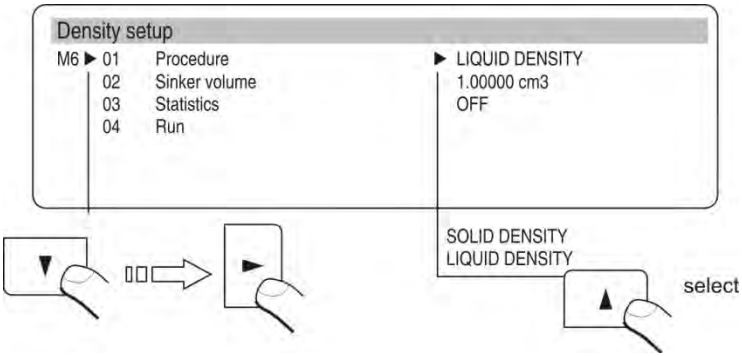


Fig 5. Density of liquid – menu preview

Procedure
Select the density determining procedure to be carried out.

Sinker volume
Volume of the sinker is given on its hook. Insert this value to balance's memory and save it.

Statistics
Statistics are calculated for the following density measurements, if option STATISTICS is enabled (set to: YES) in mode's options.

Run
Start the procedure.

8.5 DENSITY MEASUREMENT OF SOLIDS

Assembly the density determining kit for solids.

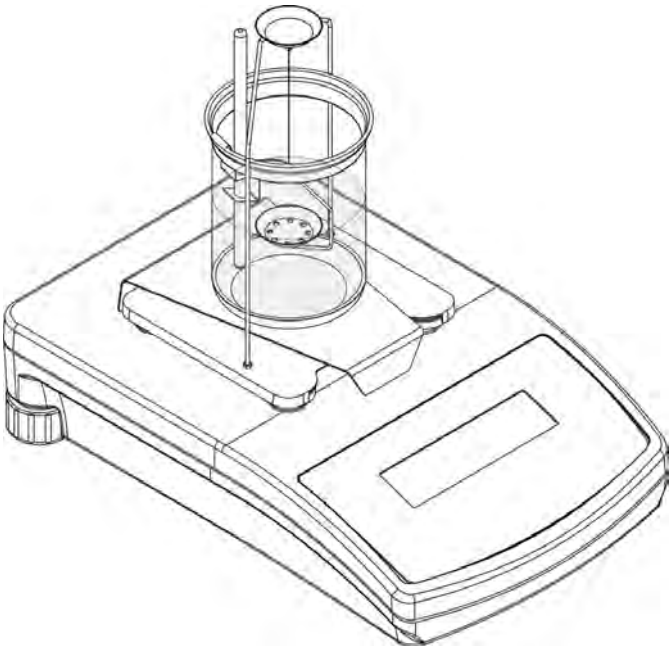


Fig 6. Balance PS series with assembled density determining kit for solids

Procedure:

1. Disassemble the weighing pan.
2. Assemble the pan of the density kit.
3. Place the beaker on the stand in a way it does not touch the weighing pan.
4. Assemble the thermometer in its handle and assemble the handle onto beaker's edge.
5. Pour into the beaker liquid in which the sample will be tested. (about ¾ of beaker's capacity)
6. Assemble weighing pans stand centrally inside the beaker.
7. Check temperature of liquid in the beaker. During density measurement liquid temperature should be stabilized (liquid density depends on temperature).
8. Preparations for density determination process of solids are completed now.
9. Press ZERO/TARE key on balance's overlay.

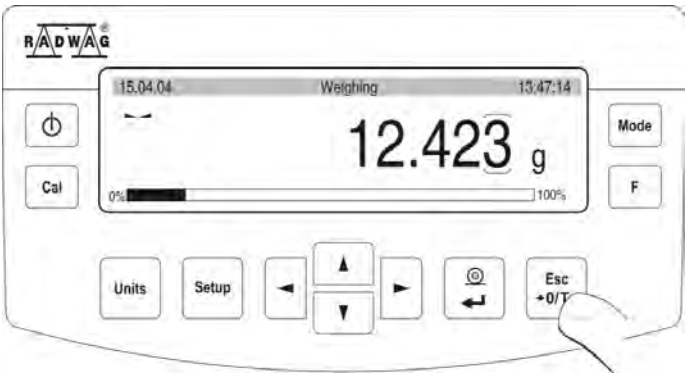


Fig 7. Tarring a balance

Select liquid in which a measurement is carried out:

- If WATER or ALCOHOL is selected, then read liquid temperature value on attached thermometer and insert it into balance's memory,
- Should statistics be used, enable them in option 05 – statistics option YES,
- Move the marker to position RUN and press F key to start the density determining procedure.

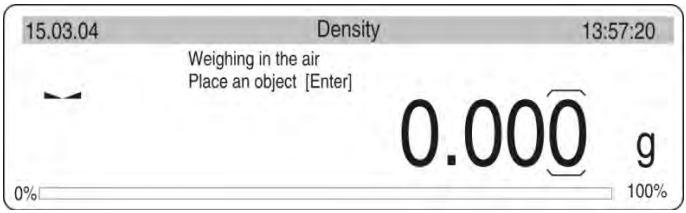


Fig 8. Density of solids – the first step in the procedure

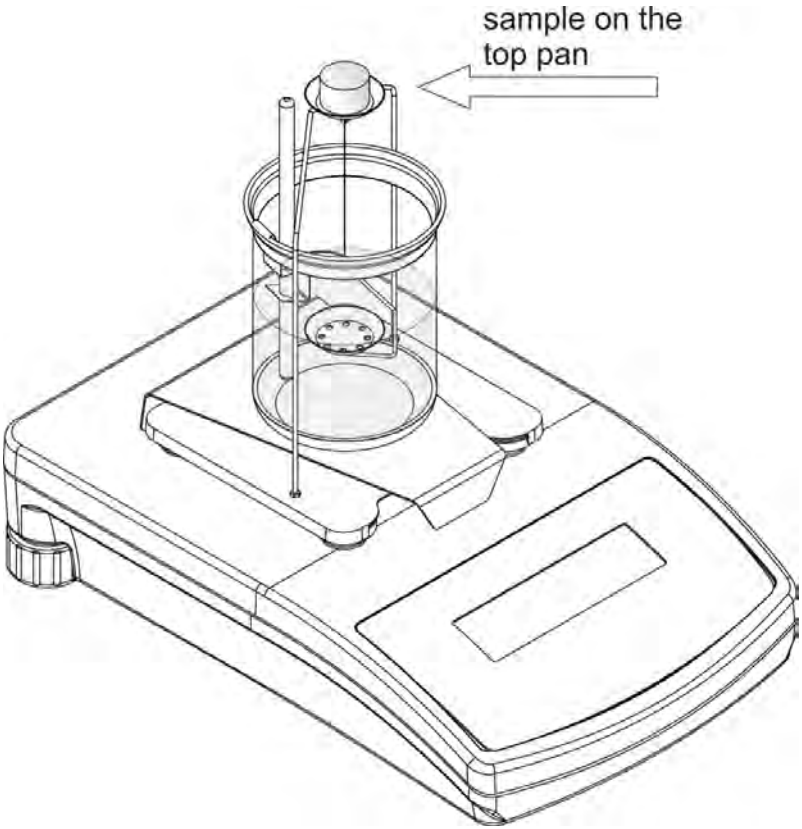


Fig 9. Weighing in the air – balance elevation

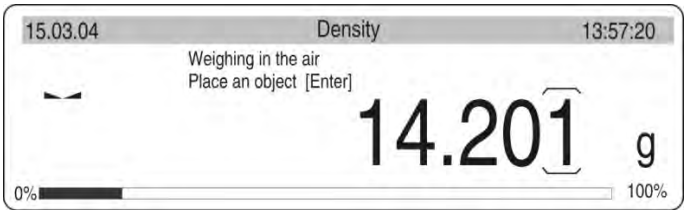


Fig 10. Weighing in the air – weighing result

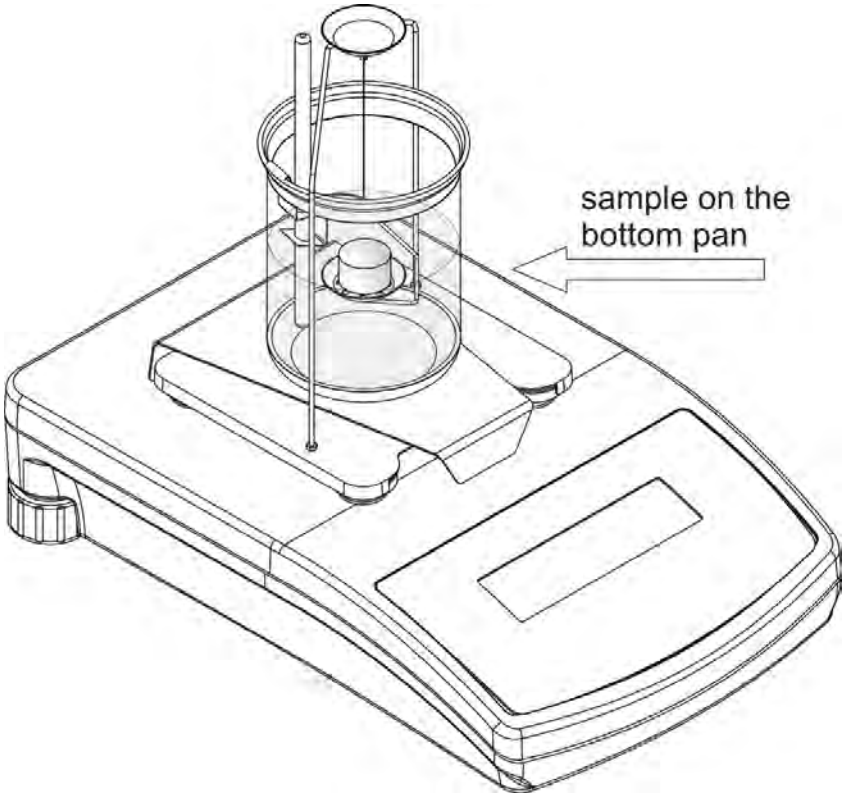


Fig 11. Weighing in liquid – balance elevation

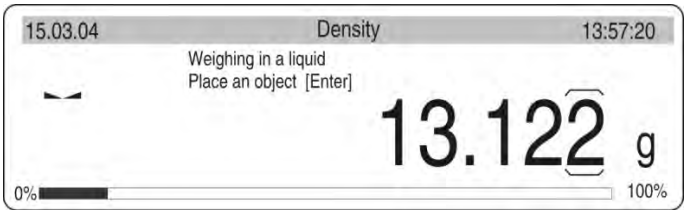


Fig 12. Weighing in liquid – weighing result

End of procedure.

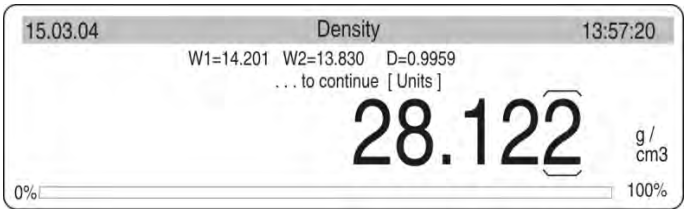


Fig 13. End of procedure – density result

Function keys:

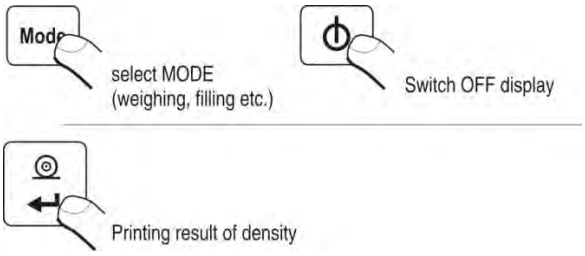


Fig 14. Function keys

8.5.1. DENSITY MEASUREMENT OF SOLIDS WITH DENSITY LOWER THAN DENSITY OF LIQUID

(the sample floats on liquid surface)

The measurement is carried out similarly to above described process. The only difference is the need to place the sample under the bottom pan during the second measurement (measuring mass of a sample in liquid).

Caution:
In case sample's displacement is larger than the pan (i.e. its weight), put supplementary load onto the bottom weighing pan.

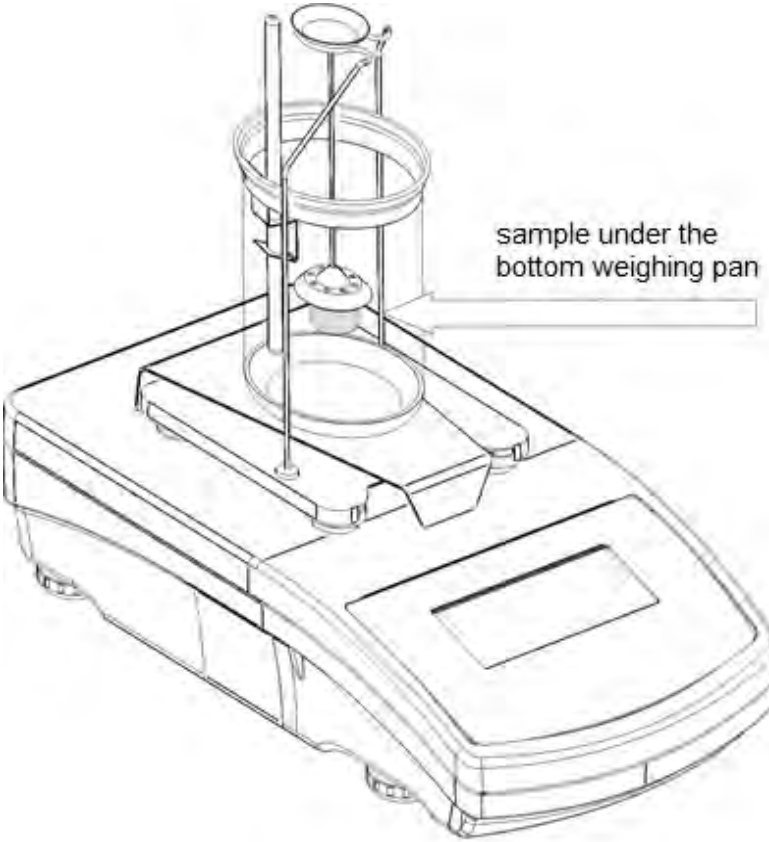


Fig. 15. Weighing in liquid – balance elevation

8.6. DENSITY MEASUREMENT OF LIQUID

Assemble the density determining kit for liquid.

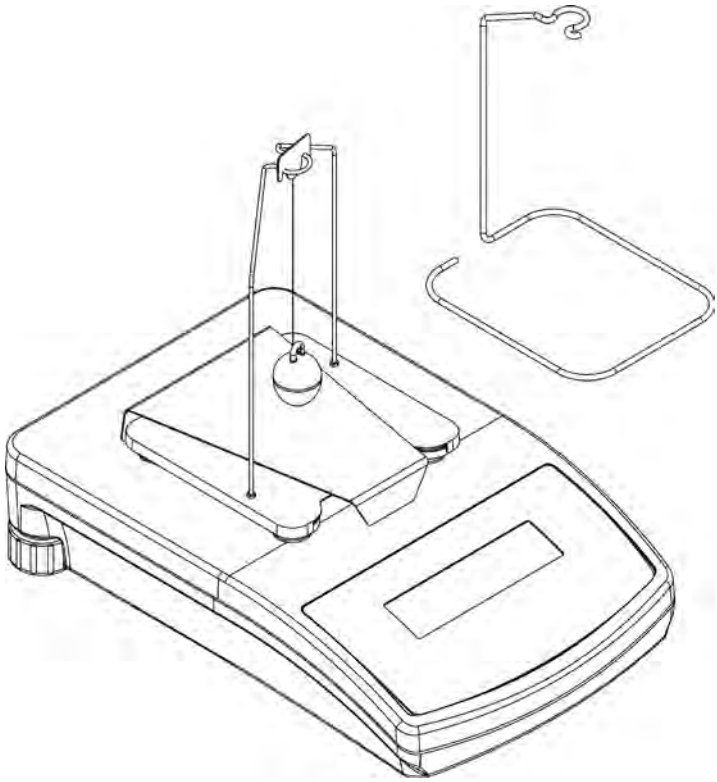


Fig 16. Balance PS series with assembled density determining kit for liquid

Procedure:

1. Disassemble the weighing pan.
2. Assemble the density kit in accordance with point 7 of this user manual.
3. If the display indicates command “null”, use supplementary weights of the density kit.
4. Press ZERO/TARE key to set the display indication to zero.
5. Pour tested liquid into the beaker – place the beaker next to the balance (amount of liquid should be fixed in a way that the sinker is completely immersed in the liquid).

Preparations for measurement process are completed now.

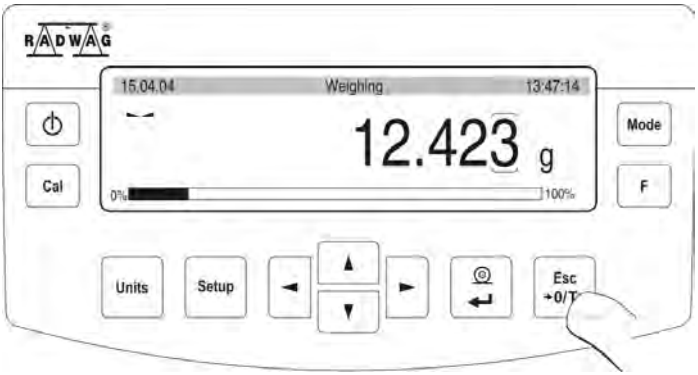


Fig 17. Tarring a balance

- Measurements start has to be carried out in accordance with description on fig 8 or fig. 9.
- Sinker's volume has to be inserted to balance's memory in field: sinker volume area volume see draw 6.
- Move the marker to RUN and start the procedure.

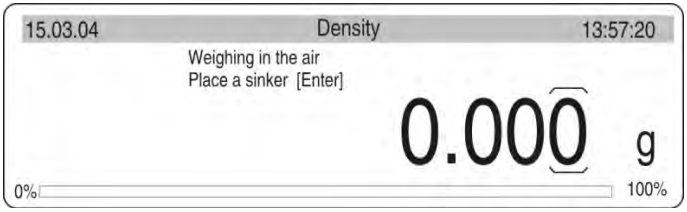


Fig 18. Density of liquid – the first step in the procedure

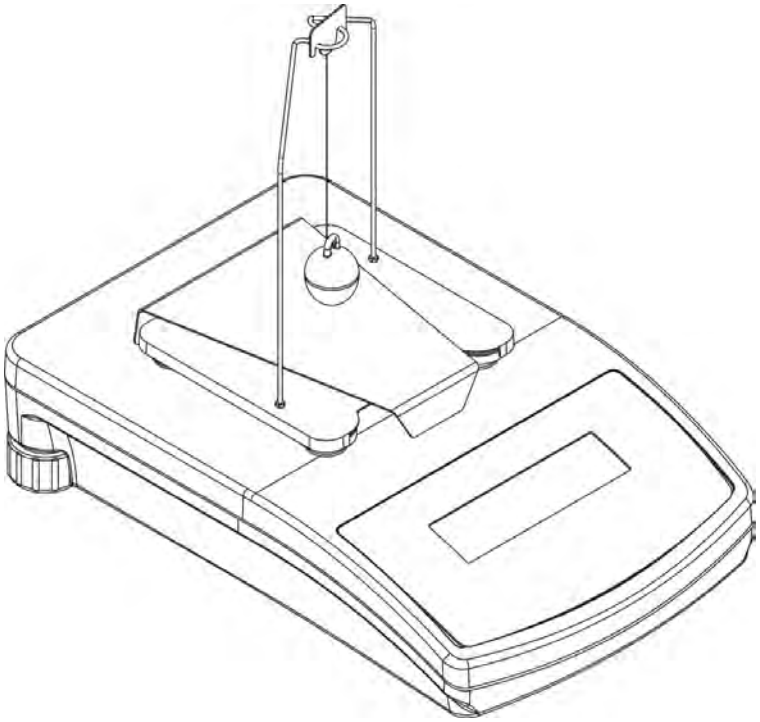


Fig 19. Weighing in the air

- Hang the sinker on the hook. As the weighing result is stabilized press Enter key.

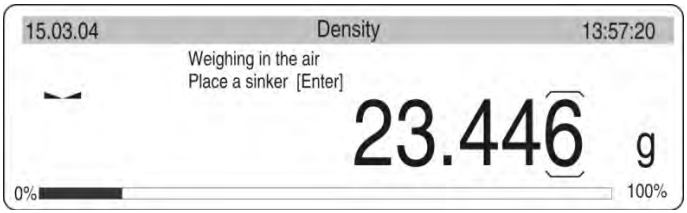


Fig 20. Weighing float in the air – display preview

- Take the sinker off the hook.
- Put the beaker with tested liquid onto the basis (the beaker must not touch the stand).
- Gently hang the sinker on the hook.

- The sinker should be fully immersed in the tested liquid.

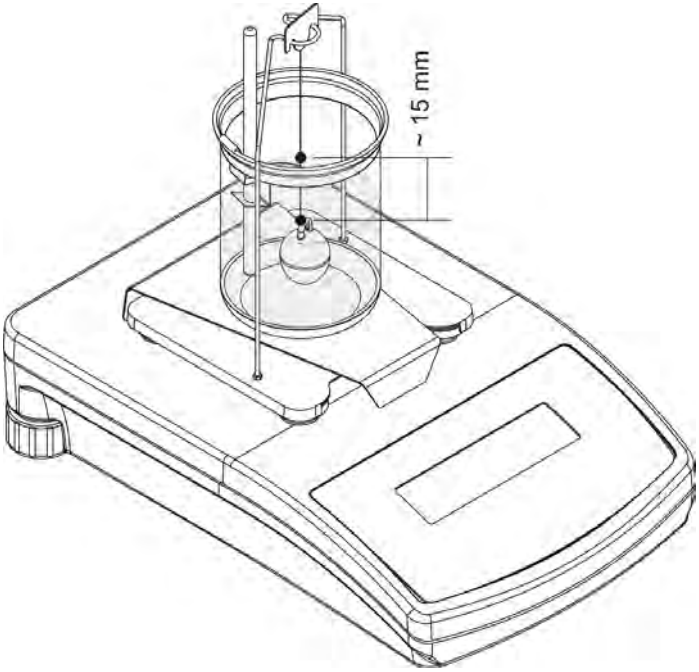


Fig 21. Weighing in liquid – view elevation

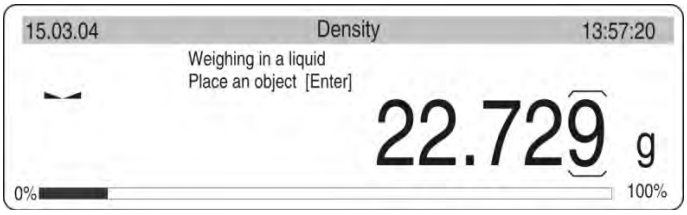


Fig 22. Weighing in a liquid – weighing result

- Press ENTER key when weighing result is stabilized.

End of procedure.

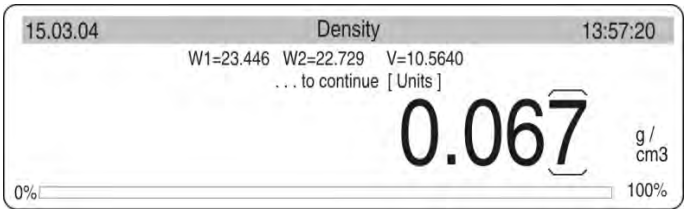
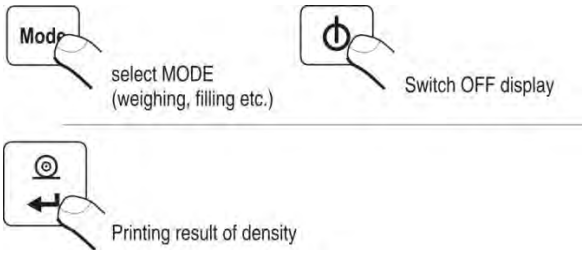


Fig 23. End of procedure – final result of density measurement

Function keys:



Fog 24. Function keys

9. DENSITY MEASUREMENT IN BALANCES PS SERIES

9.1. DENSITY MEASUREMENT OF SOLIDS

Remove the weighing pan, and instead assemble the density kit which is presented in point 7 of this user manual. Place a beaker on the basis in a way it does not touch the stand. Attach the thermometer to its clamp and assemble it to beaker's edge. Pour liquid into the beaker (distilled water, alcohol or other liquid with known density) to about ¾ of beaker's volume. Assemble the stand for the weighing pan centrally inside the beaker, then check the temperature in the beaker. Remember to keep liquid temperature inside the beaker stable during measuring process (the density of liquid depends on the temperature – its change may affect

measuring reliability). Preparations for measurement process are completed now.
Procedure:

- Press **Mode** key, then use navigating arrows to select submenu **F6 d_Co,**
- Select one of the 3 available liquid types **H20** (distilled water), **C2H5OH** (spirit 100% ± 0.1% in temp. 20^0C) or **Another** (other liquid with known density),
- for **H20** and **C2H5OH**, give liquid temperature value and follow instructions given on below figure:

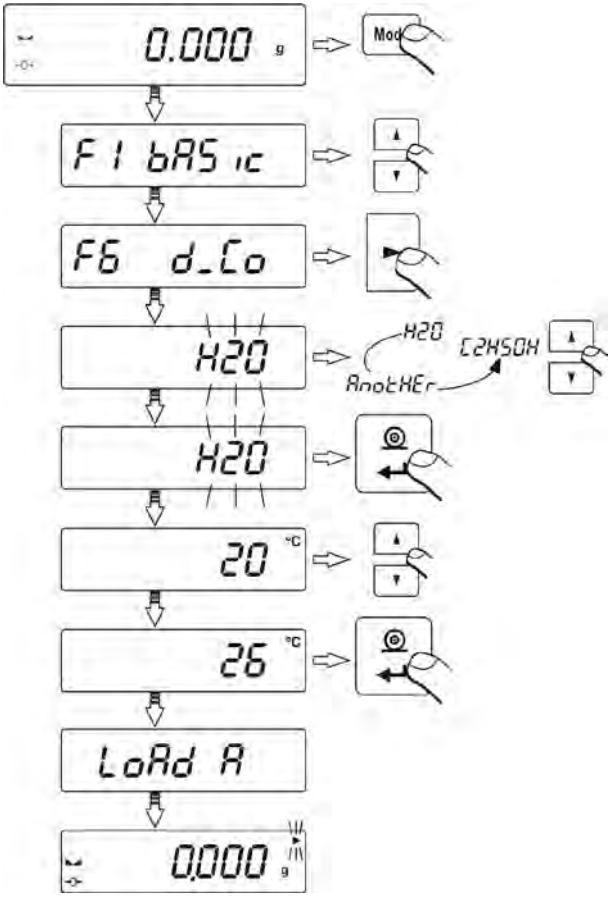


*Fig. 25. Density determining procedure of solids (selected liquid is **H20**).*

- For selected liquid: **Another**, give liquid's density and follow the instructions given on below figure:

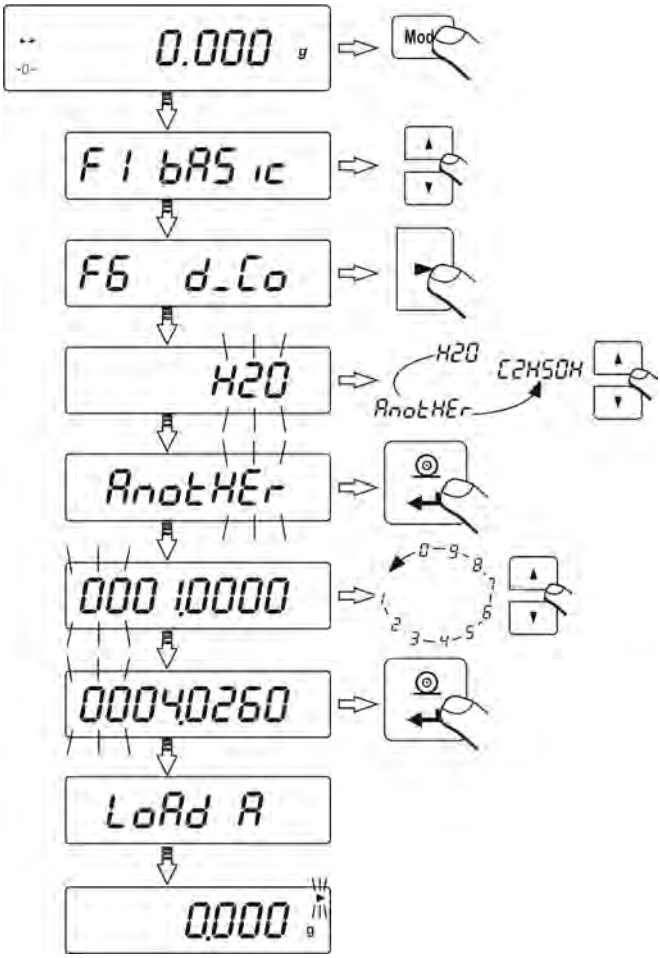


*Fig. 26. Density determining procedure of solids (selected liquid is: **Another**).*

- After selecting liquid type the balance displays command **Load A** and zero indication (if indication on balance's display is other than zero, press **ESC/ZEROTARE** key),
- Then load the sample on the top weighing of the density kit, and weigh the sample in the air.

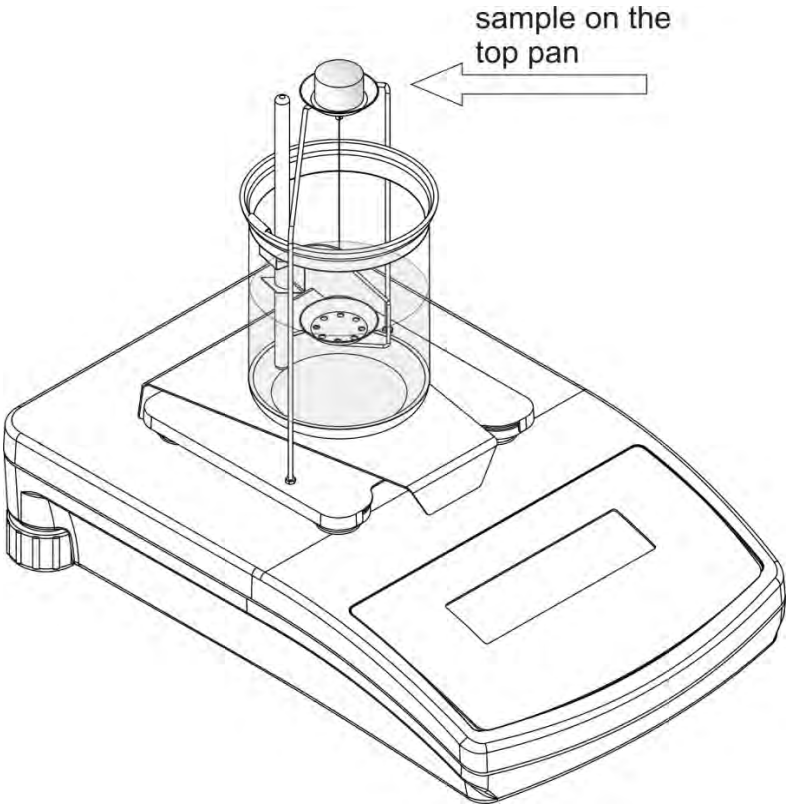


Fig. 27. Sample loaded onto the top weighing pan of the density kit

- When the balance displays stability marker press **Print/Enter** key,
- When the balance displays command **Load L** – load the sample on the bottom weighing pan of the density kit. After displaying stability marker press **Print/Enter** key,

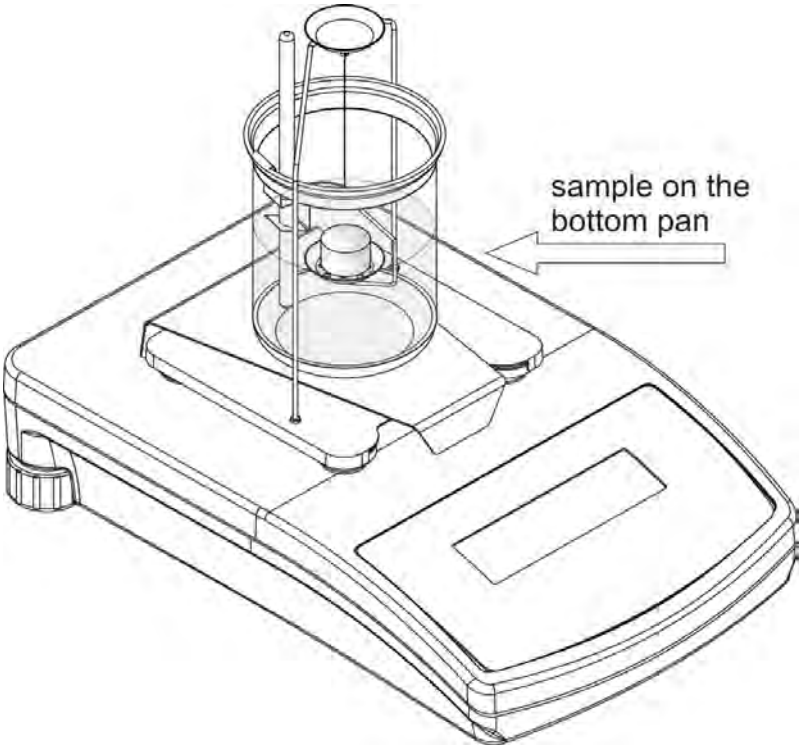


Fig. 28. Sample loaded onto the bottom weighing pan of the density kit

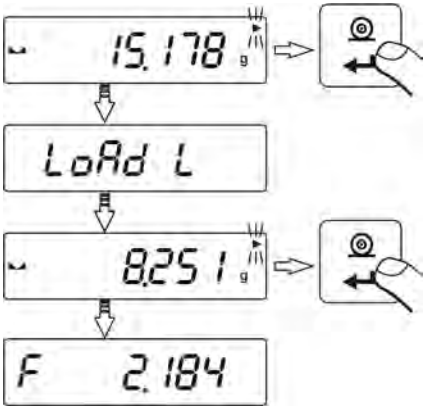


Fig. 29. Density determining procedure of solids – sample mass measurement on the top and bottom weighing pan of the density kit.

- The balance displays density measurement result expressed in

[g/cm^3].

CAUTION:
Pay special attention to presence of air bubbles during measuring process. If air bubbles are on sample's surface during measuring process, they may be a source of unreliable measurements.

To carry out repeated liquid selection, press **F** key:

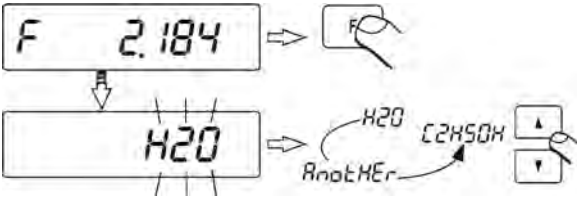


Fig. 30. Method of reselecting liquid for density determining procedure

To return to weighing mode press **Mode** key, and then **Zero/Tare** key:

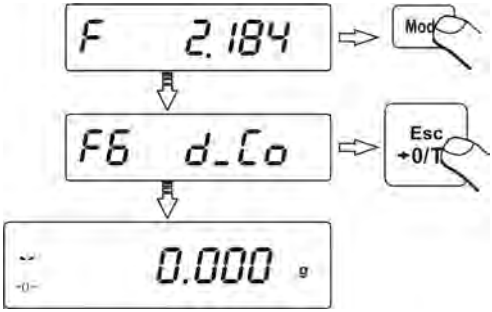


Fig. 33. Return to weighing

In order to weigh the sample again, press **Units** key:

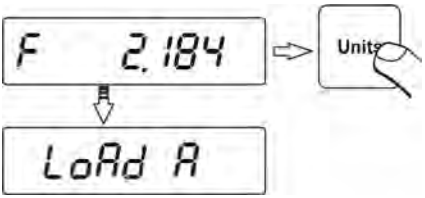


Fig. 32. Method of moving to repeated sample weighing.

9.1.1. DENSITY MEASUREMENT OF SOLIDS WITH DENSITY LOWER THAN DENSITY OF LIQUID

(sample floats on liquid surface)

The measurement is carried out similarly to above described process. The only difference is the need to place the sample under the bottom pan during the second measurement (measuring mass of a sample in liquid).

Caution:
In case sample's displacement is larger than the pan (i.e. its weight), put supplementary load onto the bottom weighing pan.

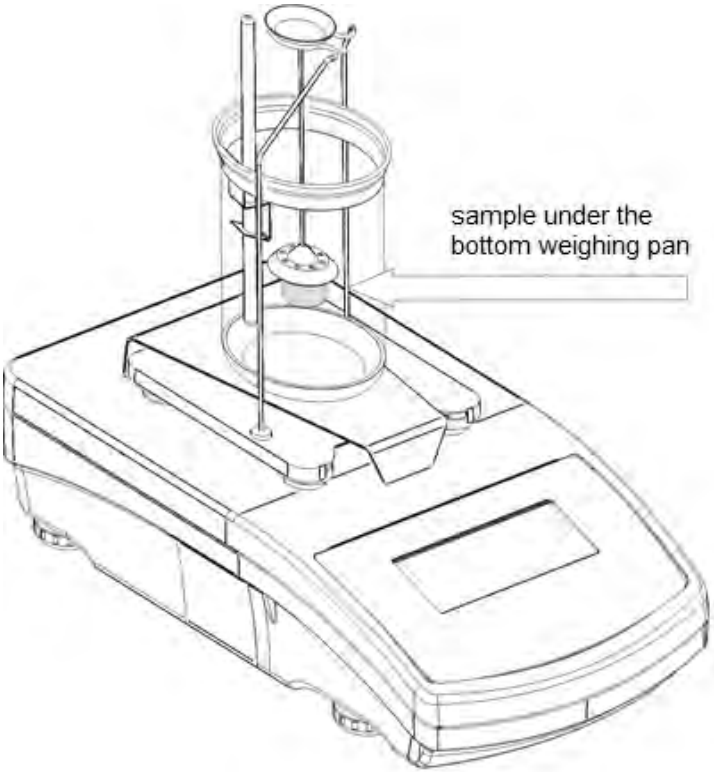


Fig. 33. Weighing in liquid – balance elevation

9.2. DENSITY MEASUREMENT OF LIQUID

Remove the weighing pan, and instead assemble the density kit which is presented in point 7 of this user manual. If the display indicates command “null”, use supplementary weights of the density kit. Press ZERO/TARE key if displayed indication is other than zero. Pour tested liquid into the beaker – the sinker should be fully immersed in the tested liquid.

Procedure

- Press **Mode** key, then using navigating arrows go to submenu **F7 d_Li,**
- Insert sinker’s volume that is specified on its hook; accuracy of the volume depends on the value given on the hook.

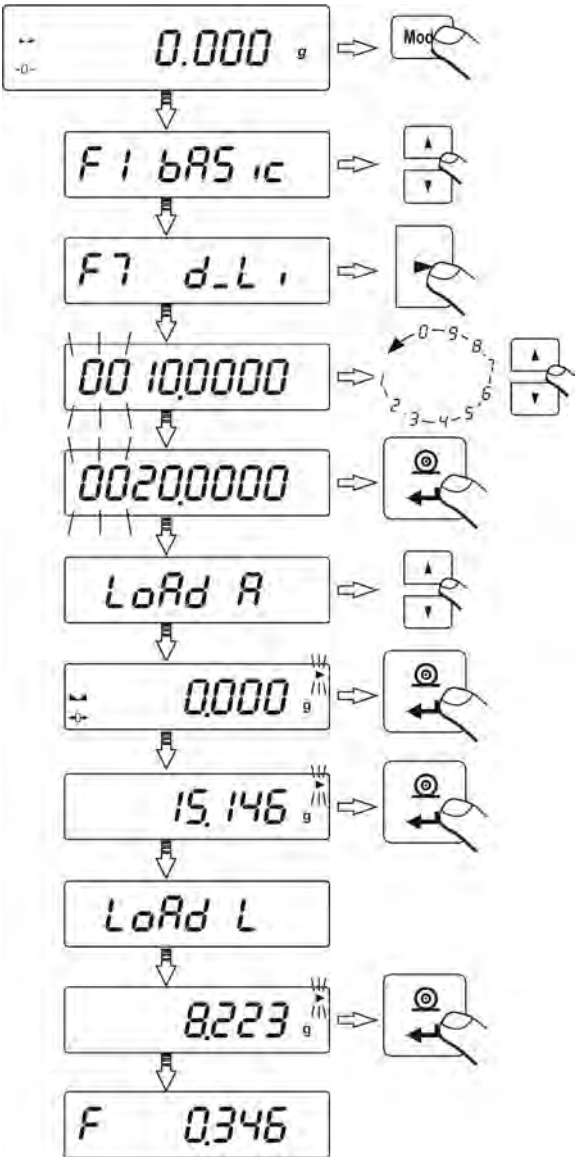


Fig. 34. Density determining procedure of liquid.

- After inserting sinker's volume and storing the data in balance's memory (using **Print/Enter** key), balance's display indicates a command **Load A** and zero (if the indication is other than zero ,

press **ESC/ZEROTARE** key),

- Hang the sinker on the density kit's basis and determine its mass in the air

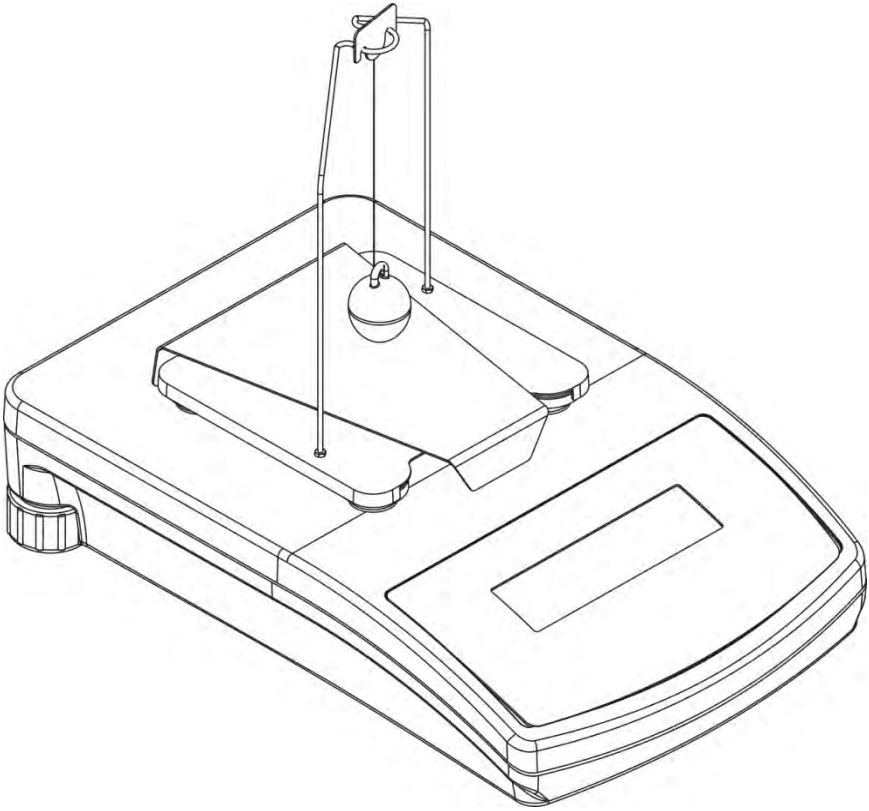


Fig. 35. Means of hanging the sinker.

- When balance indicates stable measurement marker press **Print/Enter** key,
- As the display indicates a command **Load L** – place the beaker with tested liquid on the basis and hang the sinker on the hook. The sinker has to be fully immersed in the tested liquid.
- Then determine the density measurement result by pressing **Print/Enter** key; the balance indicates the density of tested liquid in [g/cm^3].

CAUTION:
Pay special attention to presence of air bubbles during measuring process. If air bubbles tack to sinker's surface during measuring process, they may be a source of unreliable measurements.

To repeat inserting sinker's volume procedure press **F** key.

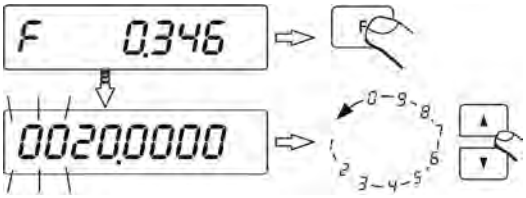


Fig. 36. Repeated entering the volume of sinker

To return to weighing mode press **Mode** key, and then **Zero/Tare** key:

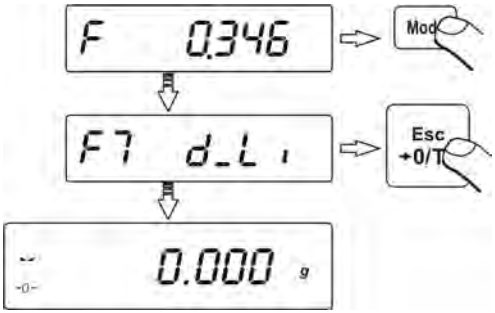


Fig. 37. Return to weighing.

In order to once again weigh the sinker in the air press **Units** key:

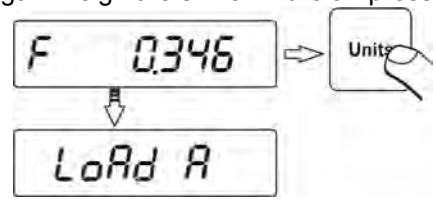


Fig. 38. Method of moving to repeated weighing process

10. DENSITY MEASUREMENT IN BALANCES AS SERIES

10.1. DENSITY FUNCTION IN THE BALANCE MENU

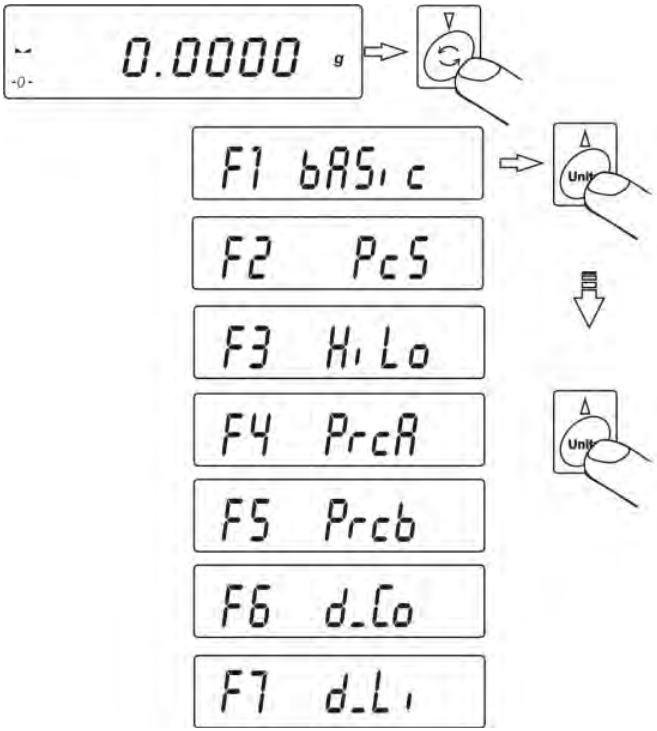


Fig 39. Balances menu – density determination mode

10.2. DENSITY MEASUREMENT OF SOLIDS

Procedure:

- Press **MODE** key, then by pressing **UNITS** key, select **F6 d_Co**.
- Press **PRINT** key to start density determining procedure.
- Press **UNITS** key and select liquid in which density will be determined.

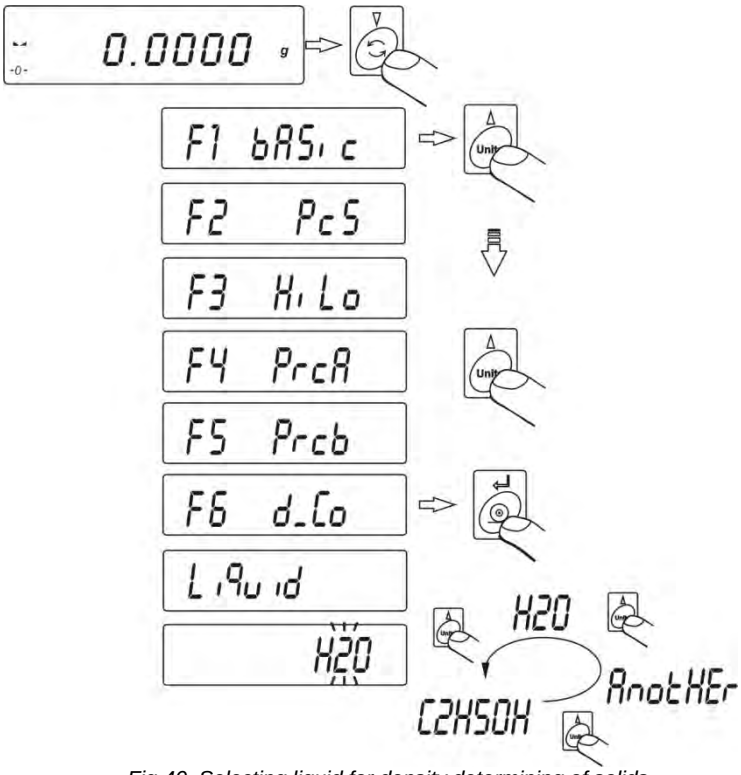


Fig 40. Selecting liquid for density determining of solids

Density of solids can be determined in three types of liquid:

- H2O (distilled water),
- C2H5OH (spirit 100% +/- 0.1% in temp. 20°C),
- AnotHEr (another liquid with known density).

- After selecting liquid accept it by pressing **PRINT** key.

If **H_2O** or **C_2H_5OH** are selected specify liquid's temperature. Read the temperature value from the thermometer attached to density kit, and enter the temperature value to the balance by pressing **UNITS** or **MODE** key.

Fig 41. Density of solids – liquid temperature

- After entering temperature value, press **PRINT** key.

If **AnotHEr** liquid was selected, specify its density.

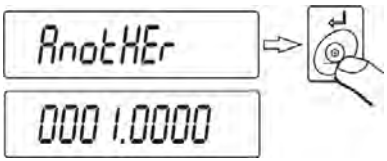


*Fig. 42 Density determining procedure of solids (selected liquid is: **Another**)*

- Press **UNITS** or **MODE** key to change the value of a digit.
- Press **F** key to select a digit.
- After selecting density of liquid press **PRINT** key to accept it.

After setting all data, the balance automatically moves to density determining process. First weigh tested sample in the air (on the top pan of the density kit) and then in liquid (bottom weighing pan).

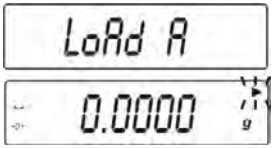


Fig 43. Solids density – measure in air

When balance's display indicates **LOAD A**, then zero, load sample on the top weighing pan of the density kit.

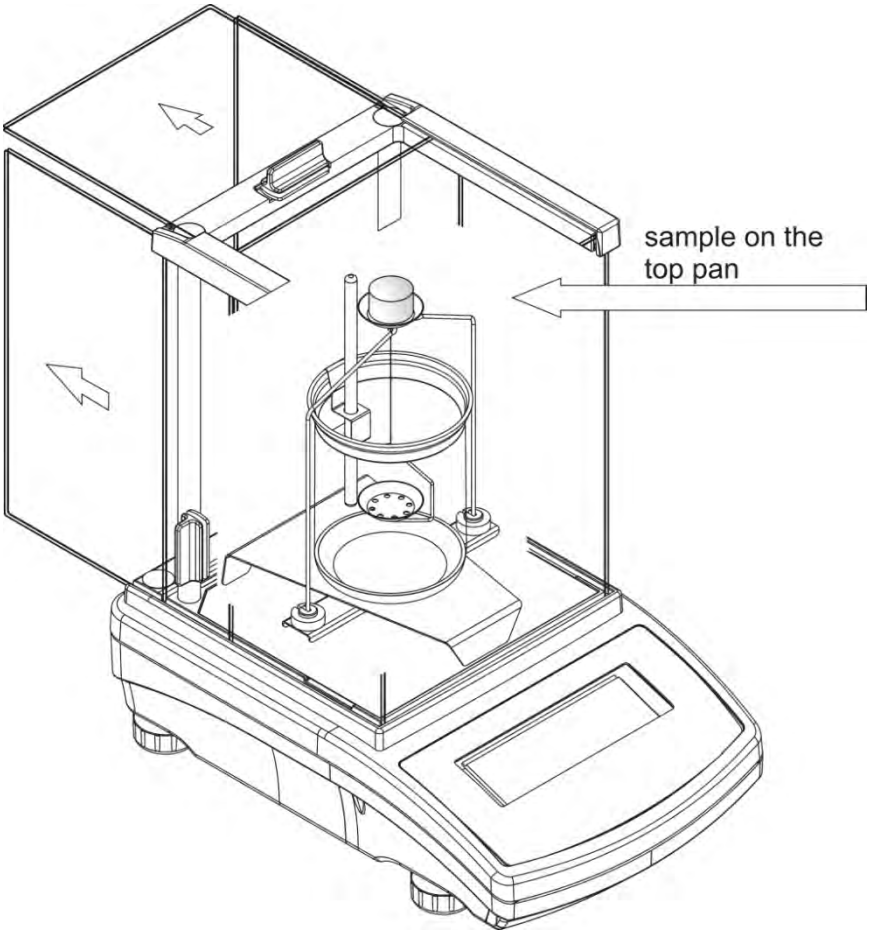


Fig 44. Density determination of solids, measurement in the air – balance elevation

- Press **PRINT** key on stable measurement result. The result is stored in balance's memory.
- The display indicates a command to place sample on the bottom weighing pan **LoAd L**.

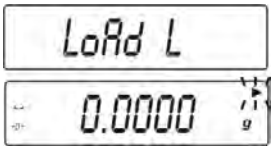


Fig 45. Density determination of solids, measurement in liquid.

As the display indicates LOAD L command, and zero indication, load the sample on the bottom weighing pan of the density kit.

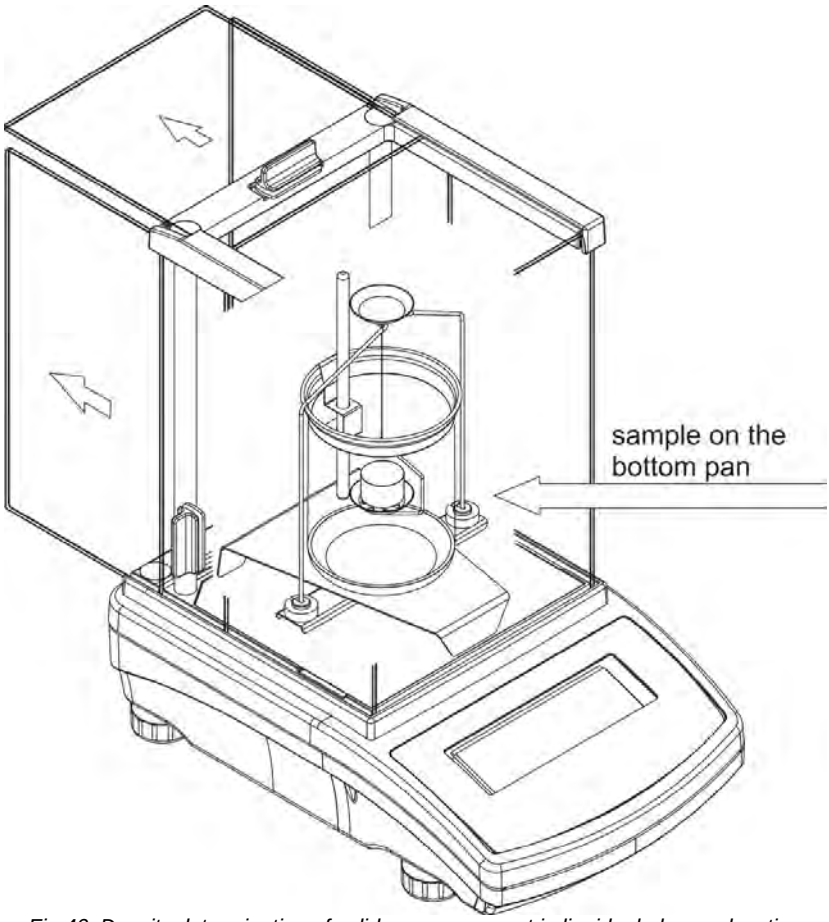


Fig 46. Density determination of solids, measurement in liquid – balance elevation

Press **PRINT** key on stable measurement result. The result is stored in balance's memory, and the display indicates the calculated value of density of a tested solid object.

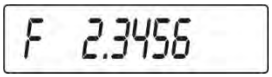


Fig 47. Density determination of solids – final density result

CAUTION:
Pay special attention to presence of air bubbles during measuring process. If air bubbles are on sample's surface during measuring process, they may be a source of unreliable measurements.

Function keys after completing the procedure

Printout result of density

Start next procedurę of solids density

Return to menu

Fig. 47 Function keys

The result is presented on balance's display is locked and expressed in [**g/cm^3**]. Press **F** key to go back to menu.

10.2.1 DENSITY MEASUREMENT OF SOLIDS WITH DENSITY LOWER THAN DENSITY OF LIQUID

(sample floats on liquid surface)

The measurement is carried out similarly to above described process. The only difference is the need to place the sample under the bottom pan during the second measurement (measuring mass of a sample in liquid).

Caution:
In case sample's displacement is larger than the pan (i.e. its weight), put supplementary load onto the bottom weighing pan.

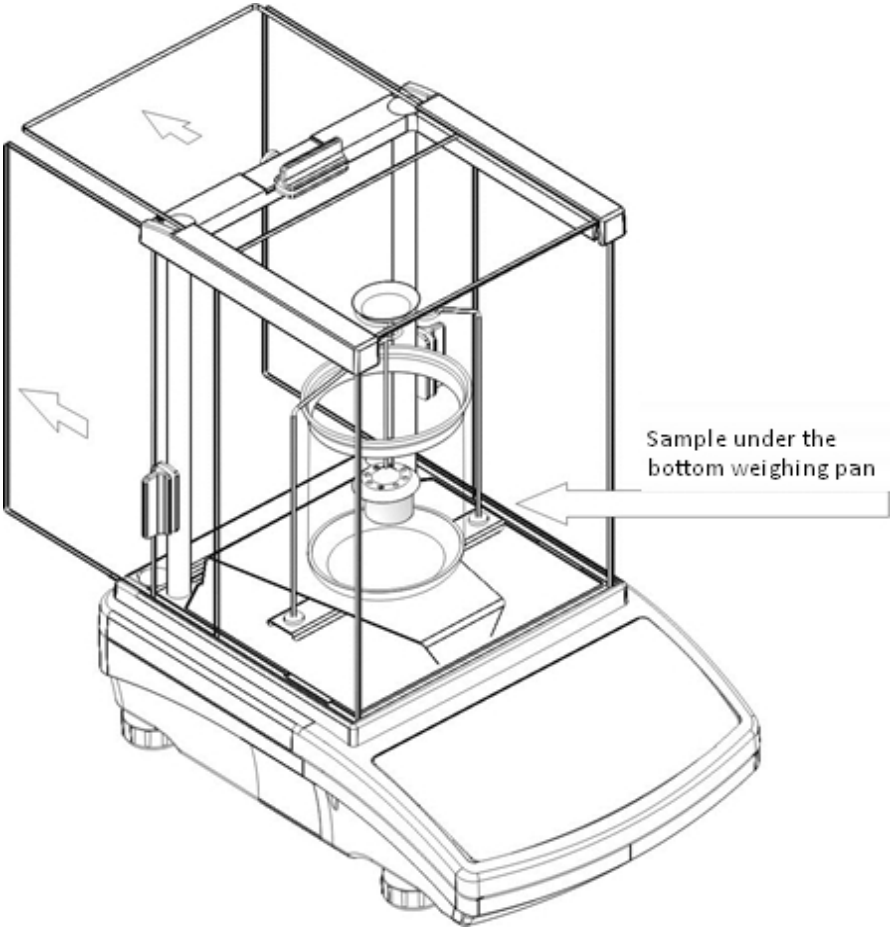


Fig. 48 Measurement in liquid – balance elevation

10.3. DENSITY MEASUREMENT OF LIQUID

Assemble the density determining kit for liquid

Procedure:

1. Disassemble the weighing pan.
2. Assemble the density kit in accordance with point 7 of this user manual.
3. If the display indicates command “null”, use supplementary weights of the density kit.
4. Press ZERO/TARE key to set the display indication to zero.
5. Pour tested liquid into the beaker, amount of liquid should be fixed in a way that the sinker is completely immersed in the liquid.
6. Preparations for measurement process are completed now.

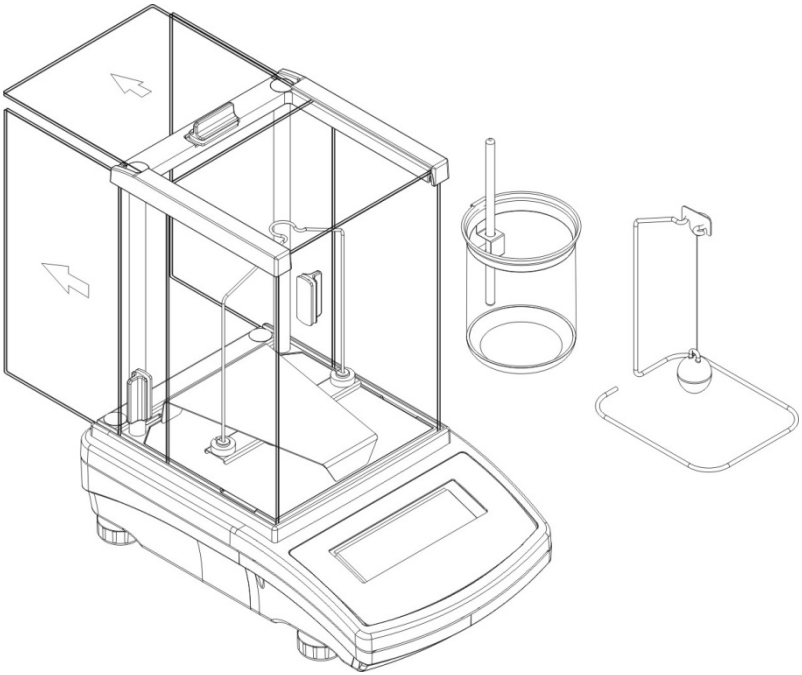


Fig 49. Density determination of liquid – preparations

Measuring procedure:

- Press **Mode** key, then using navigating arrows go to submenu **F7 d_Li,**.

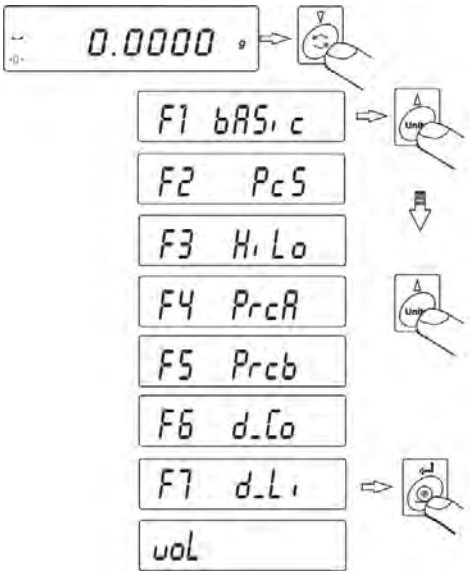


Fig. 50 Density determining procedure of liquid

- Press **PRINT** key to initiate the density determining procedure
- As the display indicates command **vol** insert volume of the sinker (it is given on sinker's hook).

Fig. 51. Density determination of liquid – setting sinker's volume

- Insert sinker's volume that is specified on its hook; accuracy of the volume depends on the value given on the hook
- Insert the sinker's volume using the following keys:
  - Press **F** key to select the digit
  - Press **MODE** or **UNITS** key to change the digit value.
  - Press **PRINT** key to accept value.

Caution:
Data on sinker's volume is stored in balance's memory.

On accepting the value, balance's indication is automatically zeroed.

The display indicates a command **LoAd A** and **0.000** appears on the display.

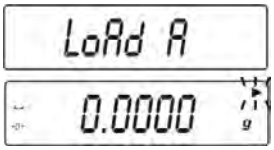


Fig 52. Density determination of liquid – step 1

Hand the sinker on the stand of the density kit and weigh it in the air..

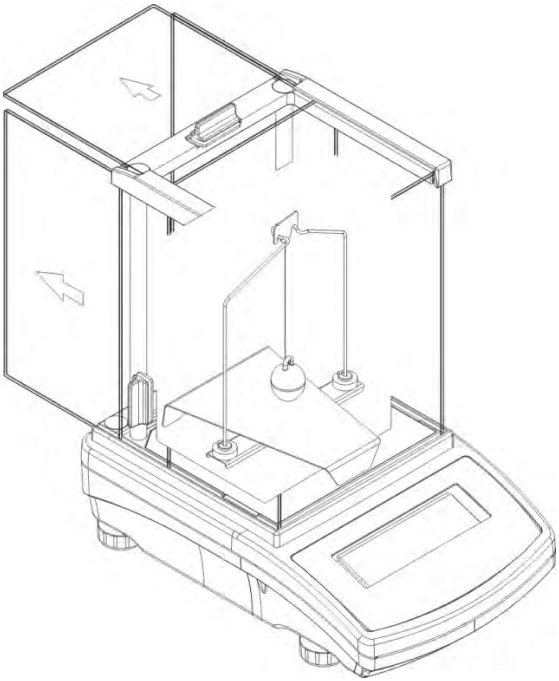


Fig 53. Density determination of liquid, measurement in the air – balance elevation

- As the measurement result is stabilized, press **PRINT** key. The result is stored in balance's memory.
- The display indicates a command **LoAd L**.

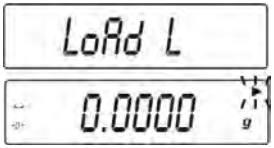


Fig 54. Density determination of liquid – step 2

Place the beaker with tested liquid on density kit's basis. Gently hang the sinker using its hook on the stand. The sinker has to be fully immersed in the tested liquid.

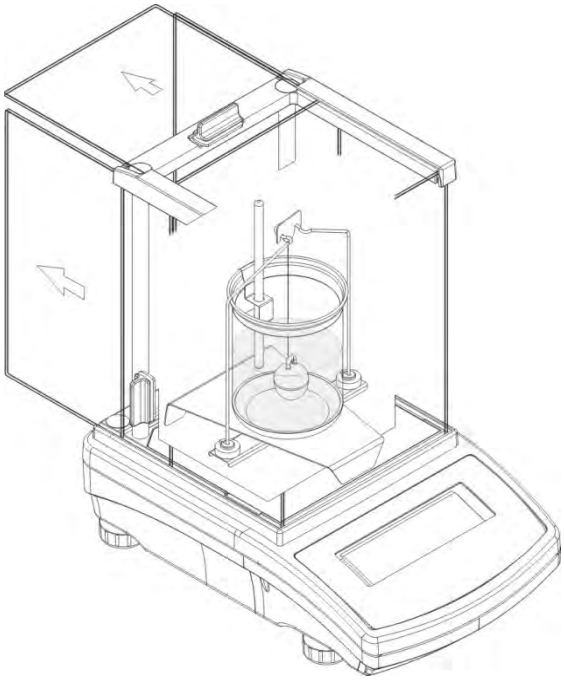


Fig 55. Density determination of liquid, measurement in liquid – balance elevation

- As the measurement result is stabilized, press **PRINT** key.
- The result is stored in balance's memory, and the display indicates calculated value of liquid density.

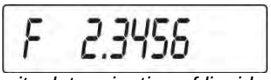


Fig. 56 Density determination of liquid – final result

CAUTION:
Pay special attention to presence of air bubbles during measuring process. If air bubbles tack to sinker's surface during measuring process, they may be a source of unreliable measurements.

Function keys on balance's overlay after completing the density determination procedure

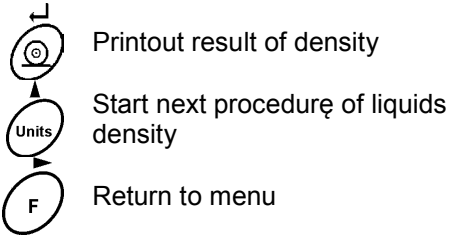


Fig. 57 Function keys

The result is presented on balance's display is locked and expressed in [**g/cm^3**]. Press **F** key to go back to menu.

11. TABLES

11.1. Table 1. Relation of distilled water density from temperature

TEMP	0	1	2	3	4	5	6	7	8	9
0	0,99984	0,99990	0,99994	0,99996	0,99997	0,99996	0,99994	0,99990	0,99985	0,99978
10	0,99970	0,99961	0,99949	0,99938	0,99924	0,99910	0,99894	0,99877	0,99860	0,99841
20	0,99820	0,99799	0,99777	0,99754	0,99730	0,99704	0,99678	0,99651	0,99623	0,99594
30	0,99565	0,99934	0,99503	0,99470	0,99437	0,99403	0,99368	0,99333	0,99297	0,99259

11.2. Table 2. Relation of water density from temperature

(Official Journal of Measures No 7/94)

Water temperature [°C]	Density of water [g/cm^3]
17,0	0,9988
17,5	0,9987
18,0	0,9986
18,5	0,9985
19,0	0,9984
19,5	0.9983
20,0	0,9982
20,5	0,9981
21,0	0,9980
21,5	0.9979
22,0	0,9978
22,5	0,9977
23,0	0,9975

11.3. Table 3. Density of some substances

(Mechanical Engineer's Handbook Vol. 1)

Name	Density [kg/m3]		Name	Density [g/cm3]
Bakelite	1270		Copper	8,9
Cotton	1300		Aluminum	2,7
Brick	1400		Iron	7,8
Sugar	1600		Platinum	21,4
Wood oak	900		Gold	19,3
Felt	300		Silver	10,5
Rubber	1200		Molybdenum	10,2
Linoleum	1200		Tin	7,3
Building paper	1100		Lead	11,4
Paper	900		Cadmium	8,65
Leather	1000		Mercury	13,6
Polished plate glass	2550		Indium	7,3
Peat	130		Bismuth	9,9
Calcareous plaster	1700		Tantalum	16,6
Glass wool	200		Nickel	8,9
Wax	950 – 980		Brass	8,4 - 8,7

11.4. Table 4. Density of types of liquid at 20 °C

(Mechanical Engineer's Handbook Vol. 1)

Name	density [kg/m^3]		Name	Density [kg/m^3]
Ammonia	610		Spindle oil	871
Petrol	680 – 740		Kerosene	800 - 850
Glycerine	1260		Ice 0^o C	917,6
Nitric acid 20%	1120		Nitrous acid	1050

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