



Adam Equipment

User Instructions for:

AE DENSITY DETERMINATION KIT
(For Luna BALANCES)

0.1 mg Analytical Balance Version
&
1.0 mg Precision Balance Version

(P.N. 3.01.6.6. 15390, Rev. A, effective April 2021)

1.0 INTRODUCTION

The Density Determination Kit (DDK) from Adam Equipment allows the users of Luna series of balances to determine the density of solids and liquids directly using the internal program of the balance.

The density kit comes with two type of pans:

- One fits the analytical models with 0.1 mg readability and 80 mm stainless steel top pan.
- The other fits precision models with 1.0 mg readability and 120 mm stainless steel top pan.

Assembly and mounting of the kits is slightly different depending on the model, but instructions for use are almost identical.

Use of the DDK with 0.01 g or higher readability interval balances is not recommended as the level of accuracy required is unlikely to be sufficient to meet requirements.

2.0 FEATURES

- Easy to use - all the activities are described by a message on the display for user.
- Reliable (all the calculations are done by the balance).
- Speed of test (the result is shown immediately after the sample is placed into the water or the float is placed into the liquid).
- Accuracy (before every measurement the balance is automatically zeroed. The user also enters the temperature of the liquid to account for density variations due to temperature or can enter the density of the liquid directly).
- Possibility to print the results or to send them to a PC for further analysis.

3.0 COMPONENTS

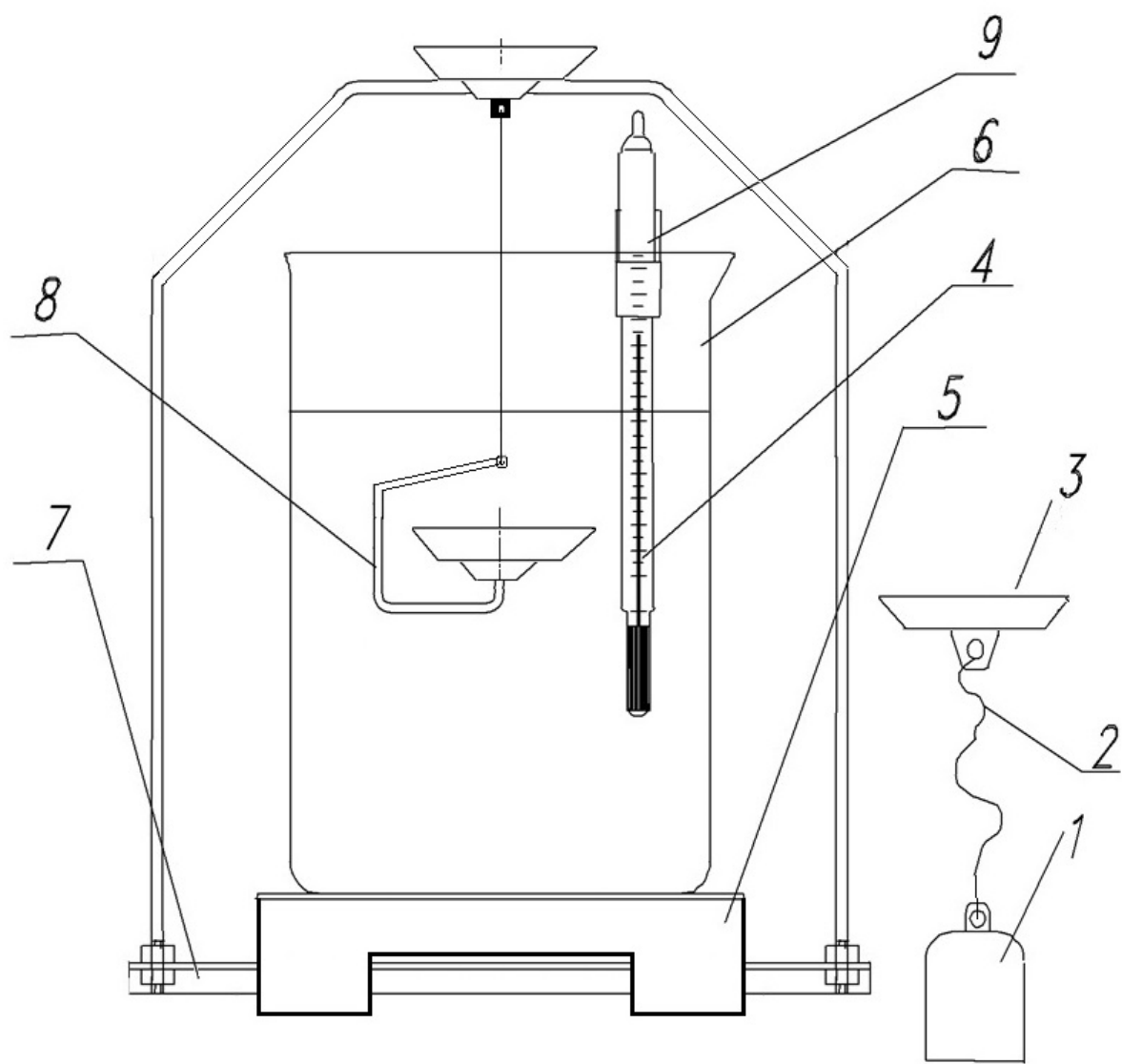
The kits consists of the following components-

1. Glass Float of known volume, with
 2. Suspension wire
 3. Hook
 4. Thermometer (mercury-free)
 5. Stainless steel base to support glass beaker (version for 0.1 mg kit with 80 mm pan shown).
 6. Glass beaker (graduated to 250 ml)
 7. Weighing Pan and Hanger – This replaces the original pan of the balance during density determination. The kit comes in two separate parts and need to be assembled (see section 4).
- } Assembly for
determining density of
liquids

Note: the 0.1 mg kit includes only a 80 mm pan, the 1.0 mg kit includes replacement pans of 120 mm size.

8. Top weighing pan,
Suspension wire
Lower weighing pan
 9. Beaker-edge clamp for thermometer
- } Assembly for
determining density of
solids

A spare wire frame is provided to store the glass float or solids weighing pan assembly in the hanging position when not in use (not shown in the diagram).

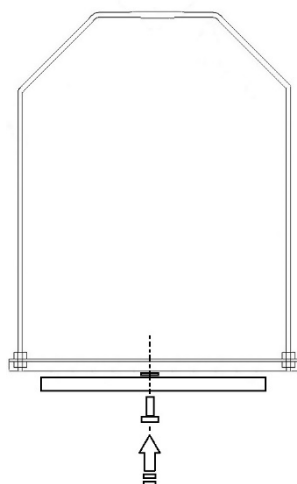


Components of the Density Determination Kit

4.0 INSTALLATION

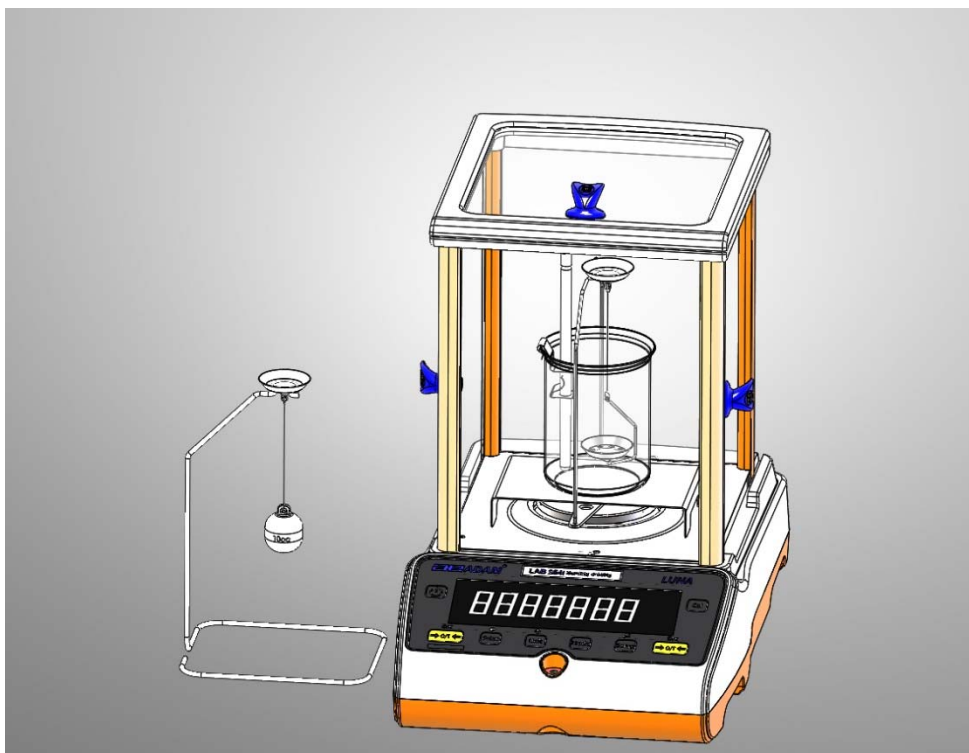
- Very carefully lift and remove the original stainless steel top pan from the balance and replace with the pan and wire frame hanger (7) supplied with the kit. (Caution: do not prise the pan off with a screwdriver or similar tool as you may exert excess force on the weighing mechanism and damage it).

NOTE: For the kit supplied, the pan with wire frame hanger (7) first needs to be assembled. Attach the wire frame to the top of the circular pan and use the screw supplied to securely fix it so it is perpendicular to and above the pan. Tighten the screw securely.

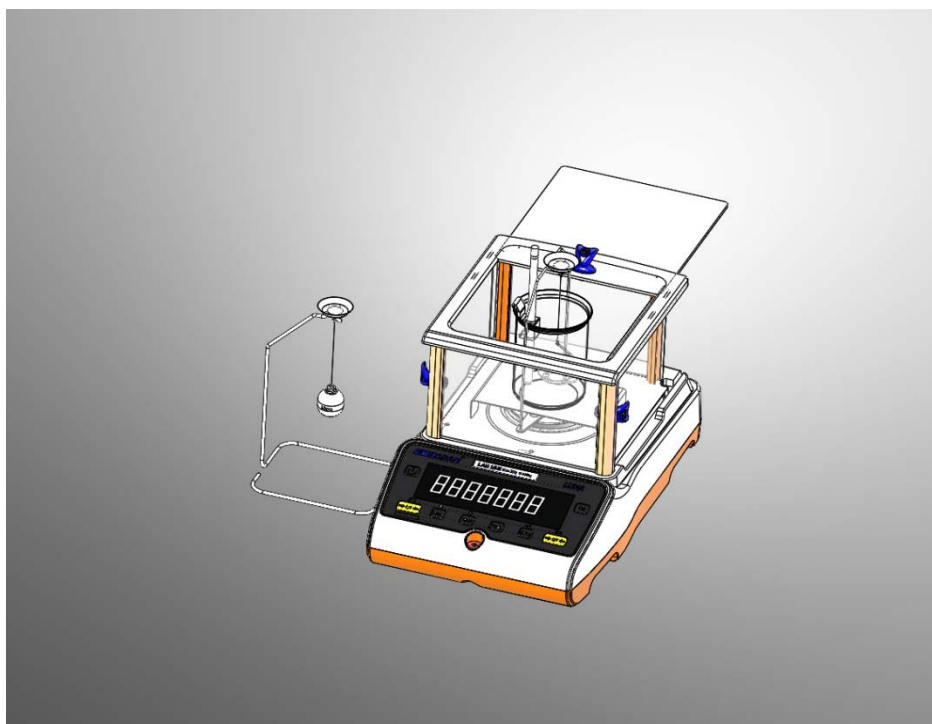


Assembly of 80 & 120mm pan

- For the 0.1 mg kit with 80 mm pan, place the beaker support (5) so it straddles the modified top pan, ensuring that they do not touch each other so that when the beaker is placed on the support, no weight is applied to the pan.
- For the 1 mg kit supplied to fit 120 mm pan, open the top glass door of the breeze shield when using the DDK.
- Hang the sample pan (8) on the hanger (7) if the kit is to be used for density determination of solids.
- Hang the glass float (1) on the hanger (7) if the kit is being used for the density determination of liquid.



LAB 254i with the Solids Density Kit installed, and Auxiliary Hanger



LPB 623i with the Solids Density Kit installed, and Auxiliary Hanger

5.0 MEASUREMENT OF SOLID DENSITY

To perform the density of solids test, the user must have a method to immerse the solid item in a chosen liquid. The density of the liquid must be known, or determined from a look-up table.

For distilled water and ethanol, the density value tables are already stored in the balance memory, and will be calculated based on the temperatures entered using the numeric entry method, when asked by the balance.

Numeric Entry Method-

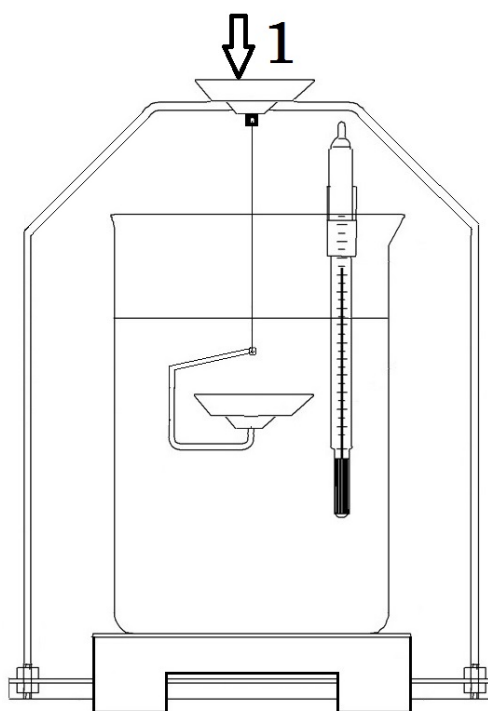
To set a value when required, use the keys as given below-

- **[Unit]** and **[Cal]** keys to increase or decrease the flashing digit,
- **[Print]** key to move left the digit
- **[Setup]** key to accept the value

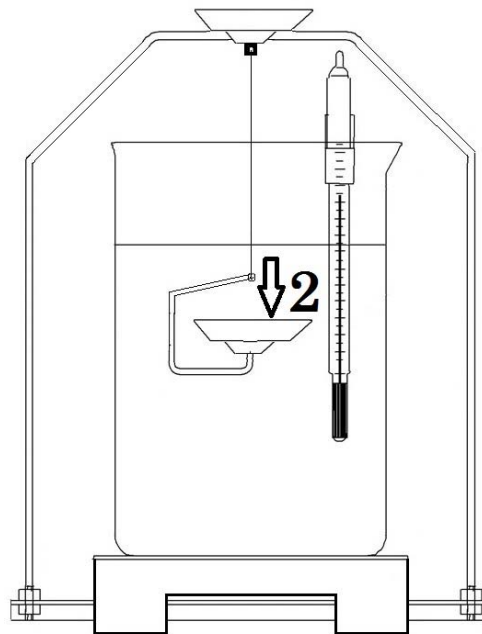
Steps:

- Install the Density Determination Kit on the pan.
- Fill the beaker (6) with either distilled water, alcohol or another liquid of known density. Allow time for the liquid temperature to stabilise to ambient temperature.
NOTE: The liquid used to fill the beaker must completely cover the bottom of the lower weighing pan (8) as well as the solid item to be weighed which will be put in this pan during the tests. This will typically require approx. 200 ml of liquid
- Fix the thermometer clip (9) on the beaker wall and insert the thermometer (4) into the liquid.
- Place the filled beaker and thermometer assembly onto the weighing base. No weight change should be caused to the balance reading as the beaker is effectively isolated from the weighing pan.
- Put the solids measuring kit in position hanging down from the top of the wire frame into the centre of the beaker. Take care to ensure that the suspending wire and pan are not touching the edge of the beaker or the thermometer or securing clip as this may cause a false reading. The lower weighing pan should be fully immersed in the liquid.
- Allow all items to stabilise to a steady state.

- Zero the balance by pressing the [**→0/T←**] key
- Press [**Mode**] and then [**Unit**] and [**Cal**] keys until the “Density” symbol is shown at the top of the display.
- Press [**Setup**] to enter the Density mode shown.
- Press [**Unit**] or [**Cal**] keys to select solid or liquid.
- If solid is selected: Press [**Unit**] or [**Cal**] keys to select the liquid of choice: **Water**, **Ethanol** or **Other**.
- Press [**Setup**] to select the choice. For water and ethanol the temperature will be asked for. Enter the temperature using the numeric entry method.
- For the “Other” choice the density will be asked for. Enter the known liquid density (g/cc) using the numeric entry method.
- Press [**Setup**] to continue.
- The balance will request for the weight of the sample in air by displaying “AIR WT”. Place the solid item on the density kit top pan (position 1). When the sample pan is stable, press [**Setup**] to determine the value.



- After completion of the air weighing, the balance will request for the weight in liquid by displaying “LIQUID WT”. Move the sample to the lower weighing pan suspended in the liquid (position 2), ensuring it is fully immersed.



- When stable, press **[Setup]** to start the liquid weighing. The balance will first display the measured weight, and then a few seconds later compute the density of the sample and display it as “DENSITY XXXX g/cc”.
- After completion of the liquid weighing, remove the solid item from the lower suspended weighing pan.
- Press **[Mode]** to continue with a new sample or press **[Esc]** to return to normal weighing.

6.0 MEASUREMENT OF LIQUID DENSITY

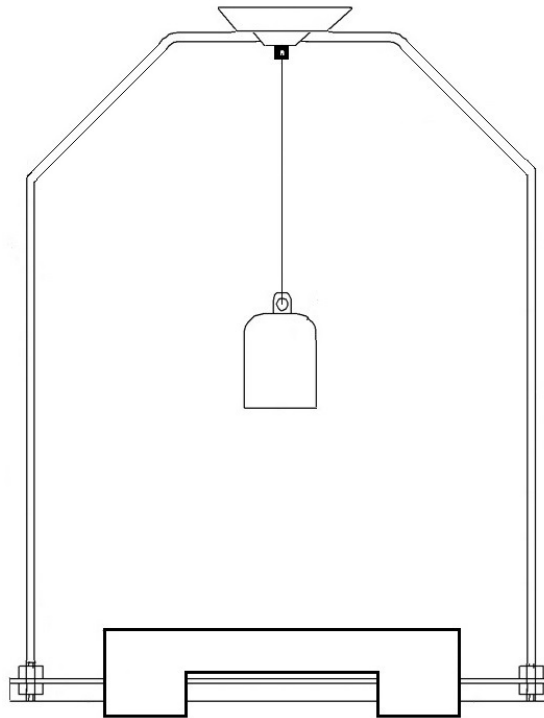
When finding the density of a liquid, it is necessary to weigh a sample of known volume in air and then in the chosen liquid. The volume of the sample must be entered using the numeric entry method. The last known volume is stored for use at any time.

In the AE density determination kit, a glass float has been provided with the volume of the float marked on its support, i.e. 10.3980. Care should be taken to ensure this value is not lost.

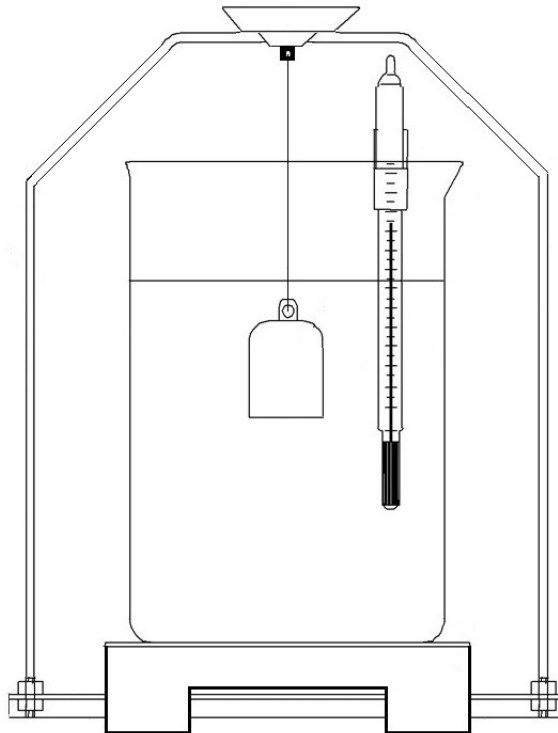
Steps:

- Install the Density Determination Kit (pan and hanger and beaker support) on the balance.
- Zero the balance.
- Fill the beaker (6) with the liquid of unknown density. Allow time for the liquid temperature to stabilise to ambient temperature.
NOTE: The liquid used to fill the beaker must completely cover the glass float which will be immersed in it during testing. This will typically require at least 200 ml of liquid.
- Fix the thermometer clip (9) on the beaker wall and insert the thermometer (4) into the liquid.
- Place the beaker assembly to one side ready for use.
- Press **[Mode]** and then **[Unit]** and **[Cal]** keys until the “DENSITY” symbol is shown at the top of the balance display.
- Press **[Setup]** to enter the Density mode shown.
- Press **[Unit]** or **[Cal]** keys to select solid or liquid.
- If **liquid** is selected: The volume will be asked for. Enter the float volume using the numeric entry method.
- Press **[Setup]** to continue.
- The balance will request for the weight in air by displaying “AIR WT”. Suspend the glass plumb supplied with the density determination kit in air on the weighing pan. When stable press **Setup]** to measure the weight of the glass plumb assembly in air.

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- On completion of the air weighing, the balance will request for the weight in liquid by displaying “LIQUID WT”.
- Place the filled beaker and thermometer assembly onto the weighing base. No weight change should be caused to the balance reading as the beaker is effectively isolated from the weighing pan.
- Submerge the glass float in the liquid.



- When stable press the **[Setup]** key. The balance will measure and briefly display the weight of the immersed glass plumb assembly, and will then compute the density of the liquid and display it as “DENSITY X.XXX g/cc”.
- Remove the float from the liquid.
- Press **[Mode]** to continue with a new liquid sample or press **[Esc]** to return to normal weighing

NOTES AND CAUTIONS:

For best accuracy follow these suggestions-

- Samples should be tested more than once and the average value be taken.
- Only distilled water should be used.
- The water should be at a stable temperature.
- The sample must be degreased.

- The sample should not be porous, hollow or with cavities or indentations. If it is porous then special preparation might be necessary.
- Ensure that the sample is completely covered by about 10mm of the liquid at the top.
- Be certain any air bubbles are removed from the liquid and surface of the sample or glass float.
- Dry the sample completely between tests.
- Be very careful not to transfer water to the top pan when using tweezers.
- Samples should be 5 grams or greater.
- Degrease the glass float before using.
- Dry the float completely between each test. Be careful not to put a static electric charge on the glass float. It may be necessary to use an anti-static cleaner on the float.
- Wash the beaker before filling it with any liquid.
- Place the sample on the weighing pans carefully to avoid shocks to the balance. Wait till the sample pan unit (8) or the glass float (1), (whichever is in use) is stable before pressing the **[Setup]** key during operation.
- Solids samples with a density of less than one can be tested. As the sample will be buoyant, then it must be tied down to the sample pan so that it is completely immersed in the liquid and does not float. The cage or clips and ties used to sink the sample must be present and weighed in both parts of the test so that they do not affect the measurement.
- Air density during the testing should have an insignificant effect on the result unless it varies substantially from normal due to extreme altitude and temperature.

- It can be demonstrated the suspension wire has a negligible effect on measurements due to weight, displacement volume, meniscus effects on the fluid present etc. and so do not significantly affect the values of results obtained. It is recommended that users study independent documents on the density determination methods used to familiarise themselves with the calculations performed and the levels of certainty of results which are possible. Repetition of tests and statistical analysis should be performed to achieve the best levels of accuracy.

APPENDIX A

A method to determine the volume of the float

To determine the volume of the float the following equation can be used.

$$V = \frac{A - B}{\rho - d} [\text{cm}^3]$$

A - mass of float in air [g]
 B - mass of float in distilled water [g]
 V - float volume [cm³]
 ρ – density of distilled water [g/cm³]
 d – density of air

The following formula is used to determine the density of air (d) to use in the above equation.

$$d = \frac{0.0012932}{1 + 0.0036728 \times t} \times \frac{p}{1013.25}$$

Where,

0.0012932 is the density of air [g/cm³] at 0°C and standard air pressure (1013.25 in millibars)

0.0036728 is the “Temperature Co-efficient” (the amount by which the air expands in volume at a constant pressure as the temperature changes)

t - temperature of air [°C]

p - pressure of air in millibars [mb]

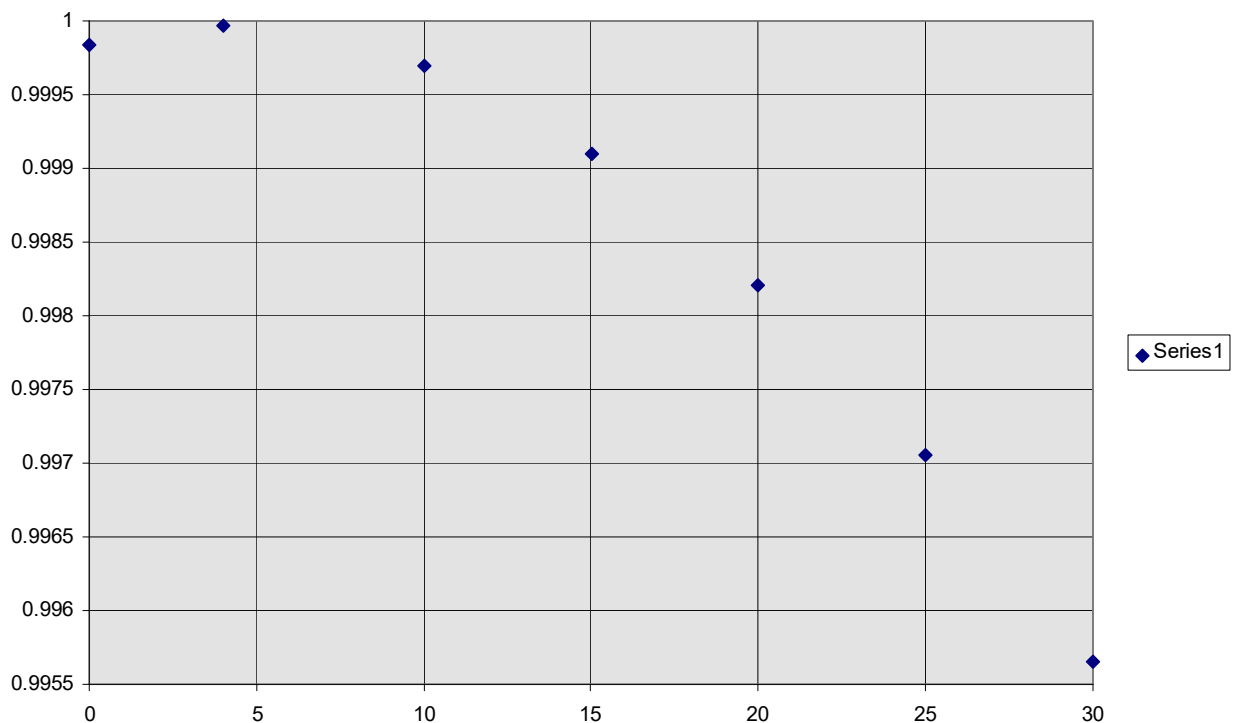
The procedure would be to measure the mass of the float in air (value A) and the mass while it is submerged in distilled water (value B) and then put the values in for the water density (ρ) and air density (d) at the temperature and pressure measured using other instruments.

The values for water density at various temperatures can be found in most chemistry or physics reference texts. A partial list is given in the following Appendix.

APPENDIX B

DENSITY OF DISTILLED WATER

WATER TEMPERATURE	DENSITY
0°C	0.99984 g/cm ³
4°C	0.99997 g/cm ³
10°C	0.99970 g/cm ³
15°C	0.99910 g/cm ³
20°C	0.99821 g/cm ³
25°C	0.99705 g/cm ³
30°C	0.99565 g/cm ³



Density of Distilled Water versus temperature

°C	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	0.99534	0.99503	0.99470	0.99437	0.99403	0.99368	0.99333	0.99297	0.99259

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