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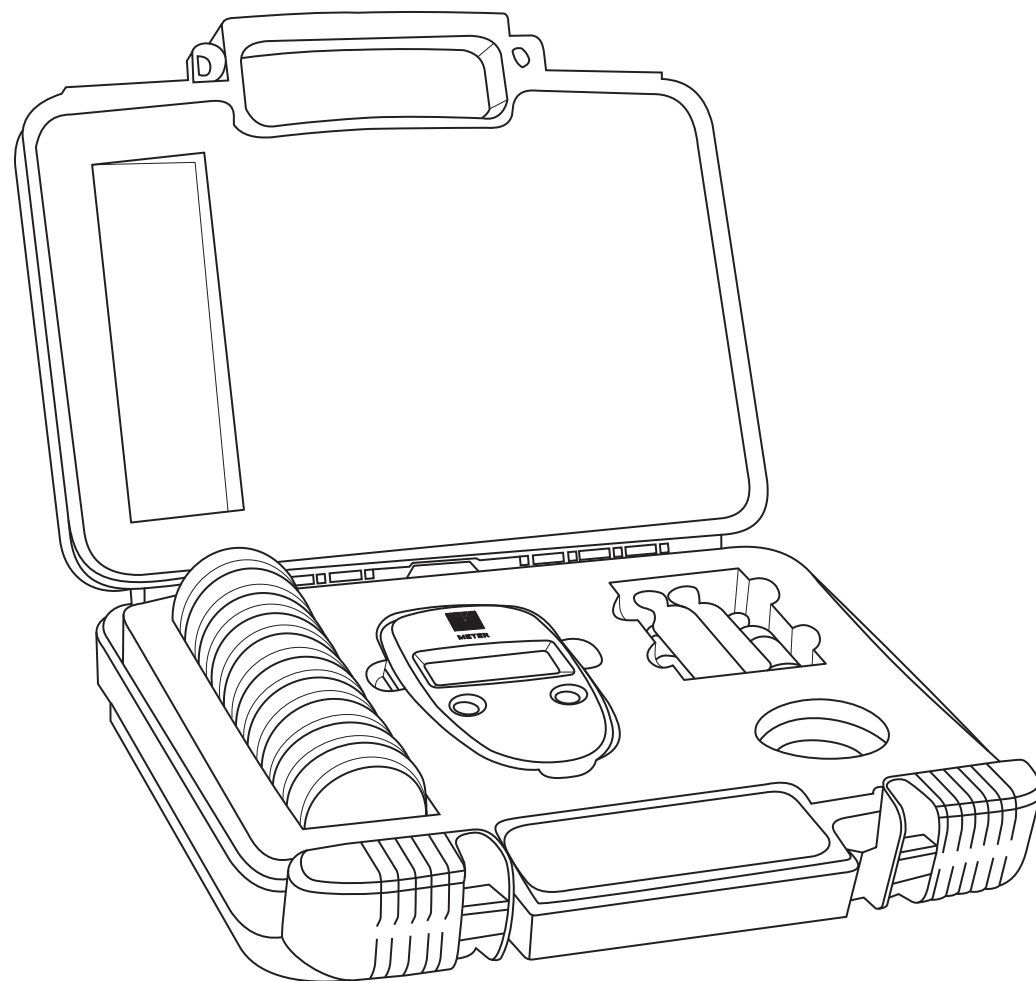
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REFERENCE

Labuza, Ted P., K. Acott, S. R. TatiNI, R. Y. Lee, Jv Flink, and W. McCall. "Water activity determination: a collaborative study of different methods." *Journal of Food Science* 41, no. 4 (1976): 910-917.

1. INTRODUCTION

Thank you for choosing the AQUALAB PAWKIT Water Activity Meter from METER Group.

The PAWKIT is designed to be a simple, rapid, and portable system for water activity measurement to ensure product safety. It is easy to use, durable, and requires little maintenance.

This manual includes instructions for setting up, verifying the calibration, preparing samples, and maintaining and caring for the PAWKIT. Please read these instructions before operating the PAWKIT to ensure that the instrument performs to its full potential.

Verify that all PAWKIT components are included and appear in good condition:

- PAWKIT main unit
- Durable carrying case
- Disposable sample cups with lids
- Spare sensor filters
- Reusable stainless steel cup
- Two vials each of the following verification standards:
  - ♦ 2.33 mol/kg NaCl (0.920  $a_w$ )
  - ♦ 6.00 mol/kg NaCl (0.760  $a_w$ )
  - ♦ 13.41 mol/kg LiCl (0.250  $a_w$ )
- AQUALAB Cleaning Kit
- Calibration certificate

2. OPERATION

Please read all instructions before operating the PAWKIT to ensure it performs to its full potential.

⚠ PRECAUTIONS

METER products are built to the highest standards, but misuse may damage the product and possibly void the manufacturer’s warranty. Follow the recommended setup instructions and arrange proper protections to safeguard products from damage.

2.1 SETUP

Follow the steps listed in [Table 1](#) to set up the PAWKIT and start collecting data.

⚠ SAMPLING PRECAUTIONS

Sensor calibration can shift when the PAWKIT is exposed to a variety of volatile substances or to samples with water activities near 1.00 over a long period of time. To prevent a sensor calibration shift, always remove samples as soon as the PAWKIT is finished sampling (a beep signals when it is finished) to avoid damage to the sensor. If a sample is accidentally left in the chamber for an extended period of time, be sure to check the calibration when the instrument is used next.

Table 1 Preparation

Tools Needed	PAWKIT unit
	Material to sample
Preparation	Plastic sample cup
	AQUALAB cleaning kit
	<b>WARNING:</b> The PAWKIT is not intended for outdoor use.
	<b>Select Clean, Level Location</b>
	Always place the PAWKIT on a level surface when measuring to ensure correct and consistent operation. This also avoids the risk of sample material spilling inside the instrument and causing contamination.
	Place the PAWKIT in a location where the temperature remains fairly stable, to avoid inaccurate readings (away from air conditioner and heater vents, windows, etc.)
	<b>IMPORTANT:</b> Temperature fluctuations or vibrations will strongly affect the accuracy of measurement results.
	<b>Sample Preparation</b>
	Prepare the sample as described in <a href="#">Section 2.1.1</a> .

4.6 TERMS AND CONDITIONS

By using METER instruments and documentation, you agree to abide by the METER Group, Inc. USA Terms and Conditions. Please refer to [metergroup.com/terms-conditions](#) for details.

Table 3 Troubleshooting the PAWKIT (continued)

Problem	Possible Solutions
Visible debris or staining	Refer to <a href="#">Section 4.2.1</a> for directions on cleaning and <a href="#">Section 4.2.2</a> for directions on changing the filter.
	Refer to <a href="#">Section 2.1.1</a> on sample preparation. Be careful to not get sample on the rim of the cup. Wipe the rim before placing the instrument on the cup.
Corrosion on thermopile	Contact <a href="#">Customer Support</a> for repair. Refer to <a href="#">Section 4.4</a> for detailed instructions.
Instrument is unstable when depressing a button	Move the instrument to a flat surface.

4.5 CUSTOMER SUPPORT

NORTH AMERICA

Customer service representatives are available for questions, problems, or feedback Monday through Friday, 7 am–5 pm Pacific time.

Email: [support.food@metergroup.com](mailto:support.food@metergroup.com)  
[sales.food@metergroup.com](mailto:sales.food@metergroup.com)

Phone: +1.509.332.5601

Fax: +1.509.332.5158

Website: [metergroup.com](http://metergroup.com)

EUROPE

Customer service representatives are available for questions, problems, or feedback Monday through Friday, 8:00 to 17:00 Central European time.

Email: [support.europe@metergroup.com](mailto:support.europe@metergroup.com)  
[sales.europe@metergroup.com](mailto:sales.europe@metergroup.com)

Phone: +49 89 12 66 52 36

Fax: +49 89 12 66 52 20

Website: [metergroup.de](http://metergroup.de)

If contacting METER by email, please include the following information:

Name	Email address
Address	Instrument serial number
Phone	Description of the problem

NOTE: For products purchased through a distributor, please contact the distributor directly for assistance.

Table 1 Preparation (continued)

Installation	Sample Placement
	Place the PAWKIT over the sample cup as described

2.1.1 SAMPLE PREPARATION

Carefully prepare samples to get the best readings possible. Always use clean sampling practices to ensure accurate and repeatable readings. Follow the steps below when preparing samples.

1. Make sure the sample to be measured is homogenous.  
Multicomponent samples (e.g., muffins with raisins) or samples that have outside coatings (like deep-fried, breaded foods) can be measured, but may take longer to equilibrate. Samples like these may require additional preparation (cutting, crushing, or grinding) to obtain a representative sample.
2. Wash hands thoroughly or put gloves on prior to handling the PAWKIT and sample cup.
3. Fill the sample cup no more than half full.  
**Completely cover the bottom of the cup with the sample**, if possible. The PAWKIT is able to accurately measure a sample that leaves small spaces of the cup bottom exposed. For example, raisins only need to be placed in the cup and not flattened to cover the bottom. A larger sample surface area increases instrument efficiency by shortening the time needed to reach vapor equilibrium. However, if the sample cup is too full, contamination of the sensor becomes a risk, which can lead to inaccurate readings.
4. Clean the bottom, edges, and rim of the sample cup thoroughly with KIMWIPES® strips ([Section 4.2](#)).  
Wipe any excess sample material from the rim of the cup with a clean KIMWIPES tissue. Material left on the rim or the outside of the cup can be transferred to subsequent samples and may affect the reading accuracy. The rim of the cup forms a vapor seal with the sensor. Any sample material left on the cup rim may prevent this seal and contaminate future samples.

If a sample reading will be taken at a later time, put the sample cup disposable lid on the cup to restrict water transfer. To seal the lid, wrap tape or Parafilm® wrapper completely around the cup/lid junction. It is necessary to seal the cup if it is going to be a long time before measurements will be made again.

The PAWKIT makes its most accurate measurements when the temperature of the sample and instrument are within 1 °C. If the sample is too warm, the thermometer icon on the left of the screen appears ([Figure 1](#)).

OPERATION

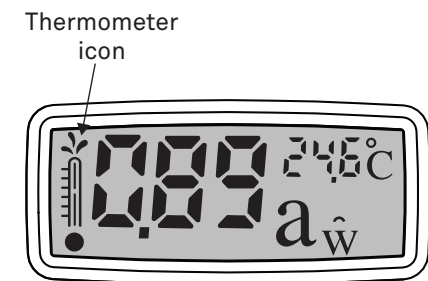


Figure 1 Thermometer icon on screen

The instrument beeps, when the sample temperature is too high, indicating there is a danger of condensing water in the sample chamber and on the sensor. If this warning appears while sampling, remove the PAWKIT, place the cup lid on the sample, and wait until the sample has reached ambient temperature before attempting to read again.

If the sample is colder than the ambient temperature of the PAWKIT, the accuracy of the reading after 5 min may be questionable. Wait until the sample temperature is similar to that of the PAWKIT.

2.1.2 TAKING A MEASUREMENT

1. Open the PAWKIT by holding the case near the LCD with one hand and pulling down on the plastic sensor cover tab with the other hand.

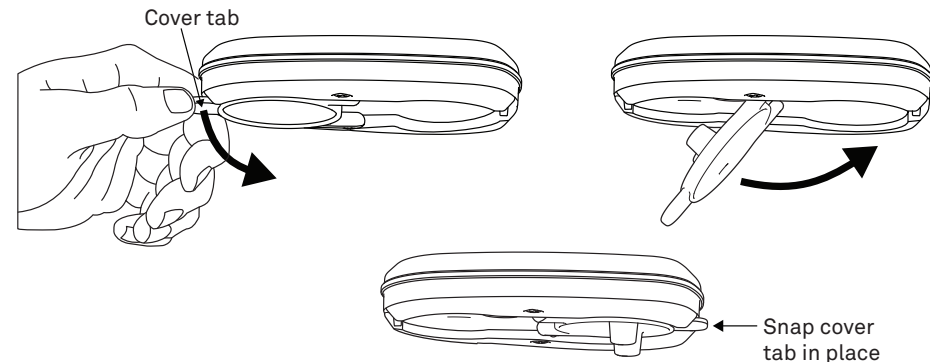


Figure 2 Open the PAWKIT

The sensor cover rotates and snaps into the open position.

PAWKIT

4.3 REPAIRS

METER repairs manufacturer defects and instruments within the 1-year warranty at no charge. Repairs outside of the warranty window are charged based on cost of parts, labor, and shipping. An extra fee may be charged for rush work. Contact [Customer Support](#) for an estimated repair cost. METER has loaner instruments available for a fee while the PAWKIT is being serviced.

All PAWKIT units returning to METER for servicing must be accompanied with a Return Merchandise Authorization (RMA) number. Prior to shipping the instrument, contact Customer Support to obtain an RMA number. The following steps should help to ensure the safe shipping and processing of the PAWKIT:

1. Ship the PAWKIT in its original hard carry case with suspension packaging.  
If it is not possible, use a box with at least 4 in of space between the instrument and each wall of the box.
2. Place the PAWKIT in a plastic bag to avoid disfiguring marks from the packaging.
3. If the original packaging is not available, pack the box moderately tight with packing material (e.g., Styrofoam® peanuts or bubble wrap), ensuring the instrument is suspended in the packing material.
4. On the RMA form, please verify the ship to and bill to information, contact name, and problem description. If anything is incorrect, please contact [Customer Support](#).
5. Tape the box in both directions for added support.
6. Include the RMA number in the attention line on the shipping label.

A Certificate of Calibration will be issued upon completion of the work.

4.4 TROUBLESHOOTING

[Table 2](#) lists common problems and their solutions. If the problem is not listed or these solutions do not solve the issue, contact [Customer Support](#).

Table 2 Troubleshooting the PAWKIT	
Problem	Possible Solutions
Error Code 9.99	The sensor has failed. Refer to <a href="#">Section 4.4</a> for further instructions on how to return the PAWKIT for repair.
Constantly offsetting or consistently high readings.	The instrument may be dirty. Refer to <a href="#">Section 4.2.1</a> for directions on cleaning.
	The filter may be dirty. Refer to <a href="#">Section 4.2.2</a> for directions on changing the filter.



## SERVICE

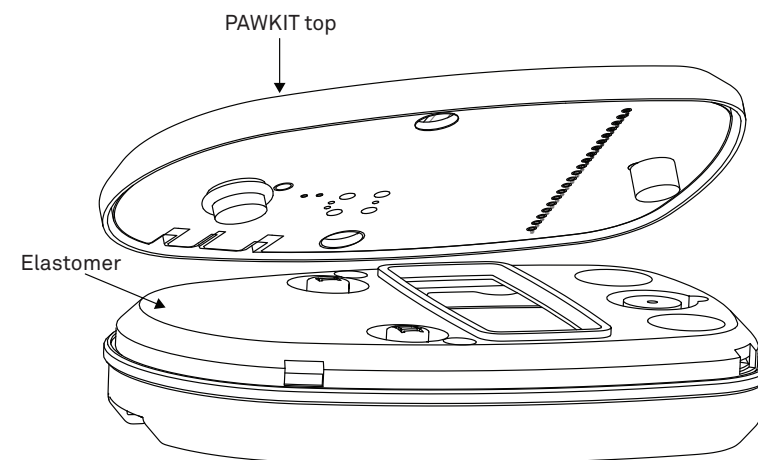


Figure 20 Separate top and elastomer

3. Remove the old lithium-ion batteries.
4. Replace with new CR1632 or equivalent 3 V lithium coin cells.

Make sure to orient the batteries so positive (+) contact is facing down into the elastomer pocket. Make sure the two small springs (Figure 21) which make contact between the (+) battery terminal and the circuit board are in place.

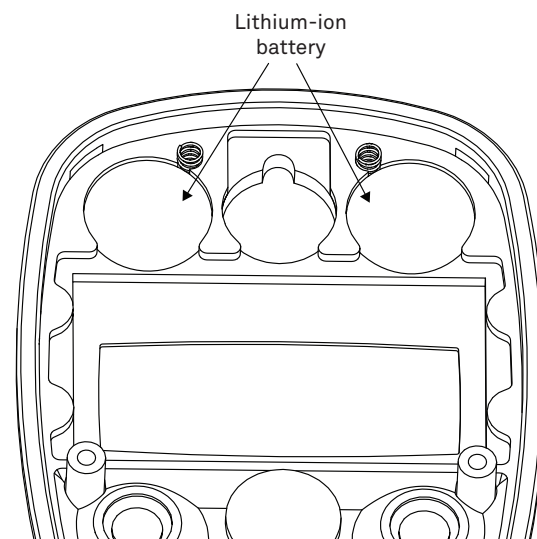


Figure 21 Lithium-ion batteries and contact springs

5. Replace the circuit board/plastic bottom in the elastomer top.
6. Tighten the two screws to complete the assembly of the PAWKIT.

## PAWKIT

2. Place the prepared sample cup onto a level surface.

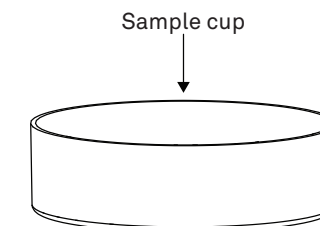


Figure 3 Sample cup placement

3. Place the opened PAWKIT onto the prepared sample cup. The cup fits under the sensor into a recess in the bottom of the PAWKIT.

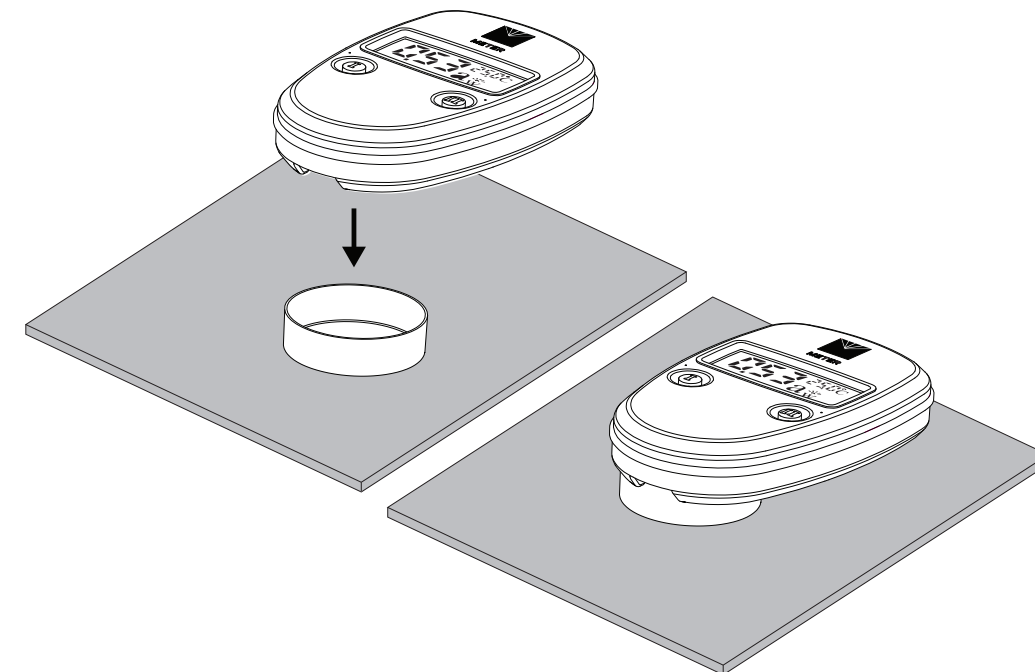


Figure 4 PAWKIT placement on sample cup

A correctly positioned cup results in the PAWKIT being level on the bench when sitting on the cup and the sensor cover legs. Ensure the rim of the cup is entirely within the recess of the sample chamber (Figure 4). Otherwise, the PAWKIT may not be level on the bench, and the cup might not make a vapor seal with the sensor.

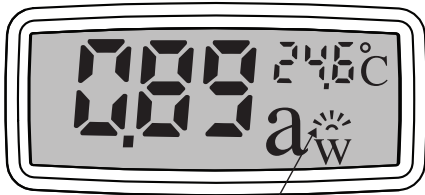
OPERATION

4. Press the I button (located on the left) to turn on the instrument.
- The instrument will display the last reading taken. This allows the PAWKIT to take a measurement without anyone attending the instrument throughout the measurement. If the PAWKIT is already on, proceed to the next step.



Figure 5 I button

5. Press the I button a second time to begin the water activity measurement. The LCD display resets to 0.00  $a_w$ .
- NOTE:** Pressing the I button any time during a measurement restarts the water activity measurement.
- Once the measurement process has been started, the PAWKIT begins to display water activity measurements as well as temperature after 5 s, updating the display every second thereafter.
- During this time the sunburst icon to the right of the water activity value indicates it is measuring. As it measures, the beams of the sunburst move from left to right.
- NOTE:** The final water activity measurement is not displayed until the instrument beeps and the sunburst icon disappears from the screen.



Sunburst and beams icon

Figure 6 Sunburst and beams icon

PAWKIT



Low battery icon

Figure 18 Low battery icon

- Follow steps 1 through 6 below to replace battery.
1. Remove the PAWKIT bottom by unscrewing the two screws.

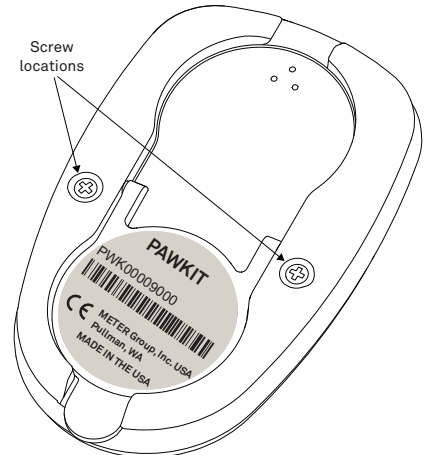


Figure 19 Battery compartment screws

2. Separate the stainless steel top and elastomer (which contains the batteries) from the white plastic bottom.

SERVICE

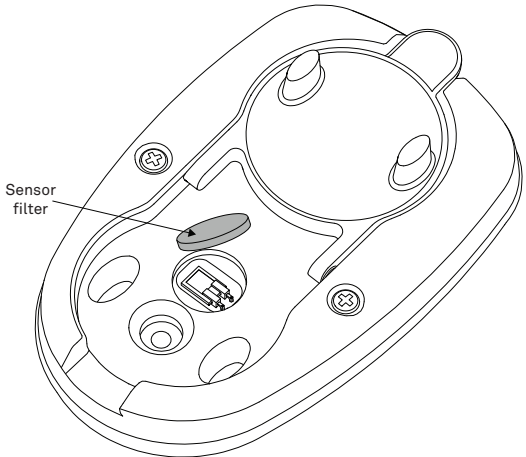


Figure 16 Filter removal

**CAUTION**  
DO NOT touch the capacitance humidity sensor because it is extremely fragile.

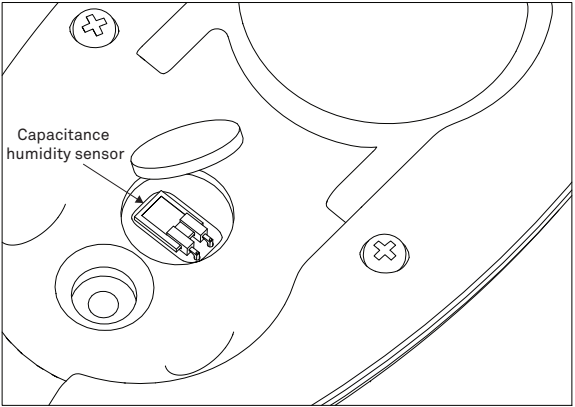


Figure 17 Capacitance humidity sensor

4.2.3 BATTERY REPLACEMENT

The PAWKIT uses two lithium-ion battery cells that should last for several years. If the battery charge is low, a low-battery indicator icon (Figure 18) will persistently appear in the lower right corner of the screen.

**NOTE:** If the low battery indication appears periodically and is not persistent, it does not necessarily mean the battery needs to be replaced.

PAWKIT

If an error code of 9.99 is received at any time during the process, it indicates that the sensor has failed and that the instrument needs to be serviced. Refer to Section 4.4 for instructions on how to return the PAWKIT for repair.

**NOTE:** DO NOT lift or move the instrument during the measurement because it could contaminate the chamber, break the chamber vapor seal, and invalidate the water activity measurement.

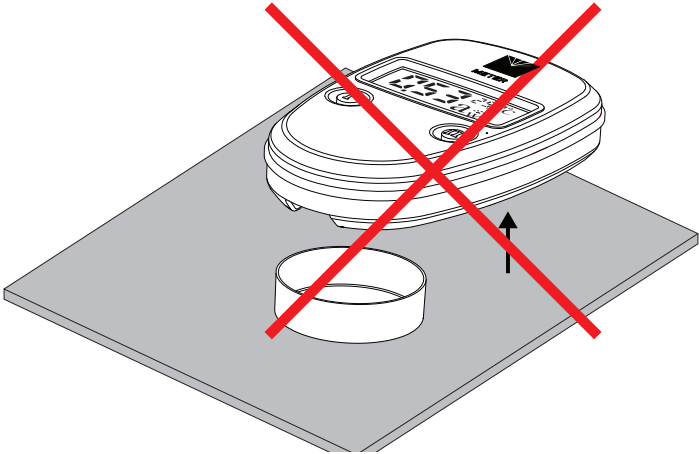


Figure 7 DO NOT lift or move instrument during measurement

- After 5 min, the instrument displays the final water activity and beeps 5 times. The sunburst disappears when the water activity reading is finished.  
**NOTE:** METER recommends recording the reading value before proceeding.  
At this point, either restart the measurement by pressing I button again or end the measurement procedure.
- Remove the sample cup by lifting the PAWKIT  
Lift the PAWKIT straight up as shown in Figure 8 to avoid spilling the sample cup. The sample may now be discarded or covered with a lid if it is to be remeasured at a later time.

OPERATION

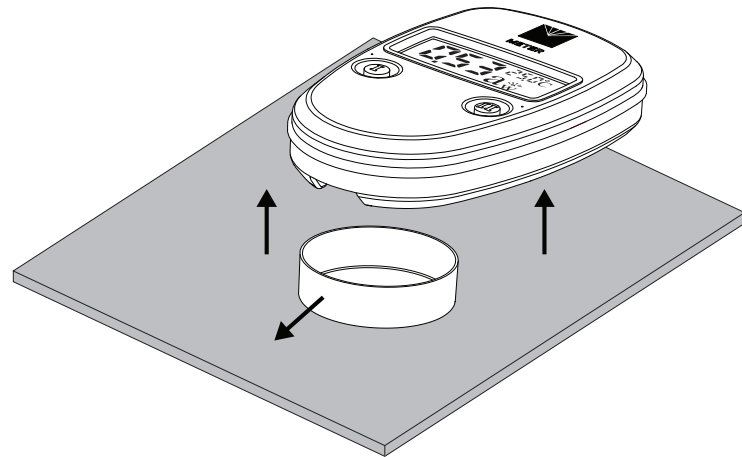


Figure 8 Remove PAWKIT when measurement complete

8. When finished taking readings, close the instrument.
- With one hand holding the case near the LCD, pull down on the plastic sensor cover tab with the other hand and rotate until it snaps into the closed position covering the sensors.

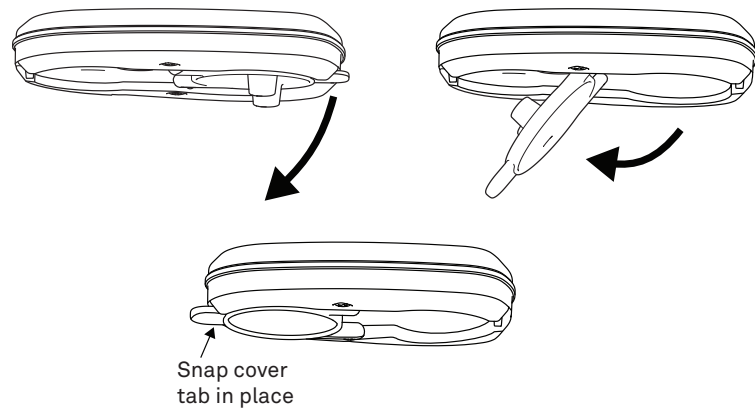


Figure 9 Closing the PAWKIT

To turn off the PAWKIT, leave it idle for more than 5 min and it will shut off automatically. If the PAWKIT has automatically shut itself off, pressing the I button wakes up the instrument and displays the last water activity measurement.

**NOTE:** Remember to close the lid before storing the case.

PAWKIT

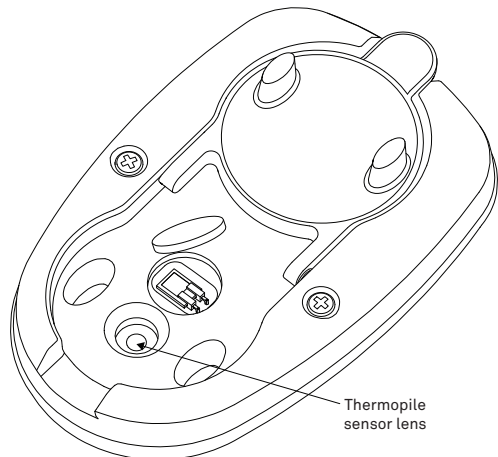


Figure 15 Thermopile sensor lens

4.2.2 FILTER REPLACEMENT

The porous white humidity sensor filter may periodically need to be replaced if it becomes dirty.

1. To remove the sensor filter use a knife or needle point to gently pry up the edge of the filter (Figure 16).
2. The PAWKIT shipped with three spare filters and additional filters can be ordered by contacting [Customer Support](#).
3. Be careful of the capacitance humidity sensor (Figure 17) when placing the new filter. Use gloves to handle the filters as finger oils can be transferred to the filter and contaminate the filter.
4. Place one edge of the filter into the sensor chamber without touching the sensor. Use a finger to push the filter into place.

SERVICE

The PAWKIT comes with the compact AQUALAB Cleaning Kit that contains all the materials needed to clean the instrument for about a year. New cleaning kits can be purchased from METER by contacting [Customer Support](#). AQUALAB offers two sizes of cleaning kits. The larger cleaning kit is primarily used for benchtop units and the compact is more useful for the handheld. The following supplies are included in the compact cleaning kit.

- Swab (a thin plastic rod)
- Steam distilled water
- Cleaning solution
- Kimwipe strips
- Cleaning procedure information card

**NOTE:** Wash hands with soap and water and/or use clean lab gloves before starting the cleaning procedure. This prevents oils from contaminating the cleaning materials, the sample chamber, and the sensors.

There are three tips for keeping the PAWKIT clean. First watch the instructional AQUALAB PAWKIT and Lite cleaning video at [metergroup.com/food/articles/pawkitlite-cleaning-video](https://metergroup.com/food/articles/pawkitlite-cleaning-video) to see step-by-step instructions on how to clean the PAWKIT.

1. Use only a soft cotton cloth to clean the LCD. Tissues can scratch the plastic, causing damage.
2. Use moist KIMWIPES tissues or soft cotton cloth to clean the rest of the outer case.
3. Begin each step cleaning the chamber and the thermopile sensor using a new KIMWIPES strip wrapped around the plastic swab included in the cleaning kit.

If sample material is spilled on the sensor filter, it does not come off. Replace the filter as explained in [Section 4.2.2](#). It is important that contamination of this filter is minimized, as the relative humidity of the sample is measured via the filter.

Cleaning the thermopile sensor lens ([Figure 15](#)), chamber area, and cup seal locations is very important for getting accurate readings. Follow the steps below to wash, rinse, and dry these areas.

1. **WASH** – Wrap a new KIMWIPES strip around the end of the swab (included in the cleaning kit; view cleaning video if needed) and moisten it with cleaning solution or isopropyl alcohol to clean the thermopile sensor lens, chamber area, and recess of the sample chamber (where the rim of the cup goes). Make sure these areas are free of all dirt, lint, and any particles that can create contamination.
2. **RINSE** – Using a new KIMWIPES strip wrapped around the end of the swab, moistened with steam distilled water, rinse the cleaning soluion from the sensor locations previously washed.
3. **DRY** – Use a dry KIMWIPES strip wrapped around the end of the swab to help remove any moisture remaining from the cleaning process.

**NOTE:** Do NOT reuse KIMWIPES strips or tissues.

PAWKIT

3. SYSTEM

This section describes the specifications, components, and theory of the PAWKIT.

3.1 SPECIFICATIONS

MEASUREMENT SPECIFICATIONS

Water Activity	
Range	0.00-1.00 $a_w$
Resolution	0.01
Accuracy	±0.02
Sample Temperature	
Resolution	0.1 °C
Accuracy	±0.2 °C
Read Time	
5 min	

PHYSICAL SPECIFICATIONS

Dimensions	
Length	10.7 cm (4.21in)
Width	6.6 cm (2.60 in)
Height	2.0 cm (0.79 in)
Case Material	
Stainless steel and valox 325 plastic	
Sample Dish Capacity	
7.5 mL, recommended (15 mL, full)	
Weight	
115 g (4 oz)	
Display	
64 × 128 graphical	

SYSTEM

ELECTRICAL AND TIMING CHARACTERISTICS

Operating Temperature	
Minimum	4 °C
Typical	NA
Maximum	50 °C
Operating Environment	
0–90% relative humidity (noncondensing)	
Power	
2–3 V 16 mm coin cell batteries (life of approximately 3 years)	

COMPLIANCE

Manufactured under ISO 9001:2015
EM ISO/IEC 17050:2010 (CE Mark)

3.2 PAWKIT COMPONENTS

Figure 10 shows the features on the top and Figure 11 shows hardware on the bottom of the PAWKIT.

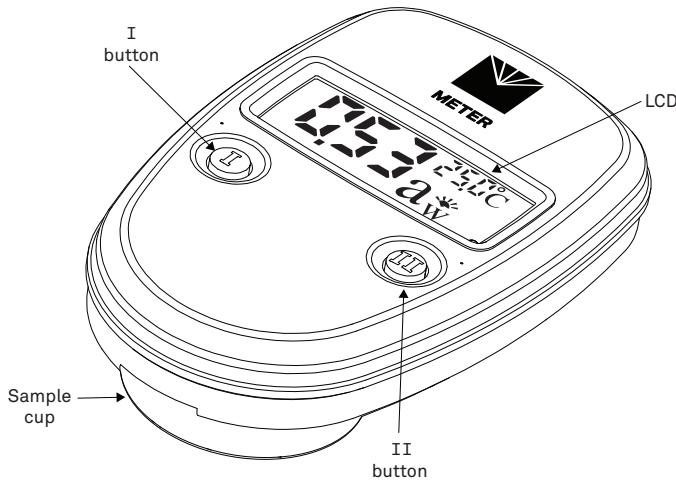


Figure 10 PAWKIT features

PAWKIT

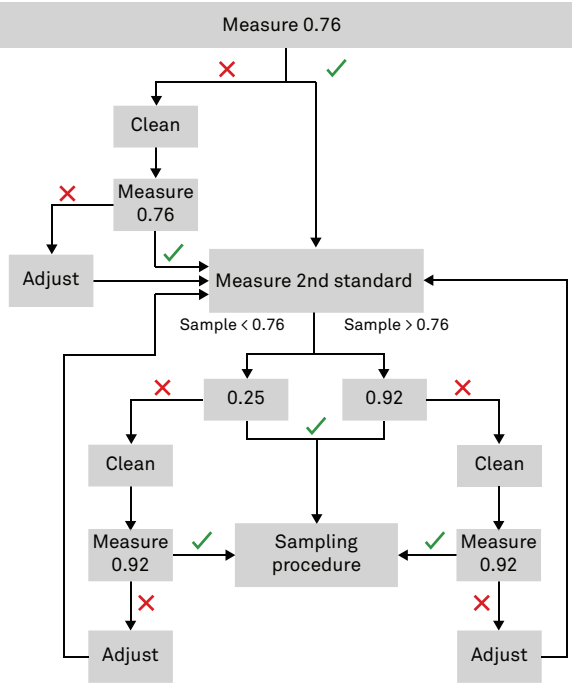


Figure 14 Calibration routine flowchart

4.2 MAINTENANCE

The PAWKIT may be returned to METER for maintenance in the following areas: system inspection, parts replacement, and instrument cleaning. Replacement parts can also be ordered from METER. Contact [Customer Support](#) for more information.

4.2.1 CLEANING

The accuracy of the PAWKIT depends on keeping the instrument clean. Dust and sample debris can contaminate the sampling chamber, and must be regularly cleaned. To clean the instrument, carefully follow the instructions in this section.

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5. Adjust the calibration.
  - a. Scroll to the proper screen for calibration adjustment.
  - b. Press the I button to adjust the correct value.

Each time the I button is pressed, the value in the corner changes by an increment of 0.01.
6. Store the new calibration value.
  - a. Scroll to the proper screen for calibration adjustment.
  - b. Press the II button to scroll until `Sto` appears in the lower right corner.
  - c. Press the I button to store the new calibration value.
  - d. Return to the main screen and begin a new measurement.

**NOTE:** If `Sto` is not pressed, no change is made to the PAWKIT calibration.
7. Verify with a second standard, either the 0.25 or the 0.92 standard.

Choose the standard that is closest to the water activity range of the sample material being tested. In other words, if it is normally higher than 0.76  $a_w$ , use the 0.92 standard. If it is normally lower than 0.76  $a_w$ , use the 0.25 standard. If the PAWKIT measures the second standard correctly ( $\pm 0.02$ ), begin testing the product. If it does not measure correctly, repeat [step 3](#) through [step 7](#) for the second standard.
8. If the calibration routine is inadvertently entered, keep pressing the II button until the main screen appears.

**NOTE:** The 0.76 standard adjustment adjusts the calibration intercept, while the 0.25 and 0.92 adjusts the slope. Changes in the intercept are more likely to occur than changes in the slope, so the 0.76 verification check is the most important and should be done more frequently.

Review the graphical representation of the calibration routine in [Figure 14](#).

PAWKIT

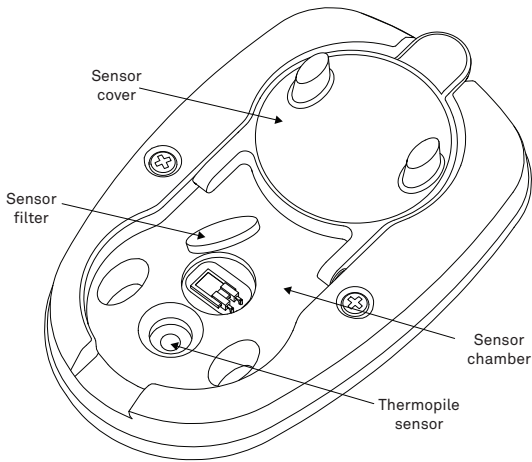


Figure 11 PAWKIT hardware

The PAWKIT uses a capacitance humidity sensor to measure the water activity of a sample. The sensor is suspended behind the sensor filter and uses a special polymer material sandwiched between two microporous electrodes to sense humidity changes. The sensor measures a specific capacitance, which is translated by the software and displayed as water activity on the instrument screen. At equilibrium, the relative humidity of the air in the chamber is the same as the water activity of the sample.

The PAWKIT is accurate to  $\pm 0.02 a_w$ . For many applications, this accuracy is more than adequate. If a higher accuracy is required, METER recommends using the AQUALAB 4TE or TDL Water Activity Meter. Contact [Customer Support](#) for more details.

The PAWKIT system comes with 60 disposable plastic sample cups and one stainless steel sample cup. Additional quantities of cups can be purchased from METER.

3.3 THEORY

Water is a major component of foods, pharmaceuticals, and cosmetics. Water influences the texture, appearance, taste and spoilage of these products. Quantifying these attributes require two basic types of water analysis: moisture content and water activity ( $a_w$ ):

3.3.1 MOISTURE CONTENT

Moisture content implies a quantitative analysis to determine the total amount of water present in a sample. There are two primary methods for determining moisture content: loss on drying and Karl Fischer titration. Secondary methods, such as near infrared (NIR) and nuclear magnetic resonance (NMR), may also be used. Moisture content determination is essential in meeting product nutritional labeling regulations, specifying recipes, and monitoring processes.



## SYSTEM

However, moisture content alone is not a reliable indicator for predicting microbial responses and chemical reactions in materials. The limitations of moisture content measurement are attributed to differences in the intensity that water associates with other components.

### 3.3.2 WATER ACTIVITY

Water activity ( $a_w$ ) is a measurement of the energy status of the water in a system. The value indicates how tightly water is bound, structurally or chemically, within a substance. The lower a sample's water activity, the more tightly bound that water is within the sample. The concept of water activity is of particular importance in determining product quality and safety. It predicts safety and stability with respect to microbial growth, chemical and biochemical reaction rates, and physical properties.

Water activity is a measure of the energy status of the water in a system and is a far better indicator of product stability than moisture content. Figure 12 shows how the relative activity of microorganisms, lipids, and enzymes relate to water activity. While other factors, such as nutrient availability and temperature, can affect the relationships, water activity is the best single measure of how water affects these processes.

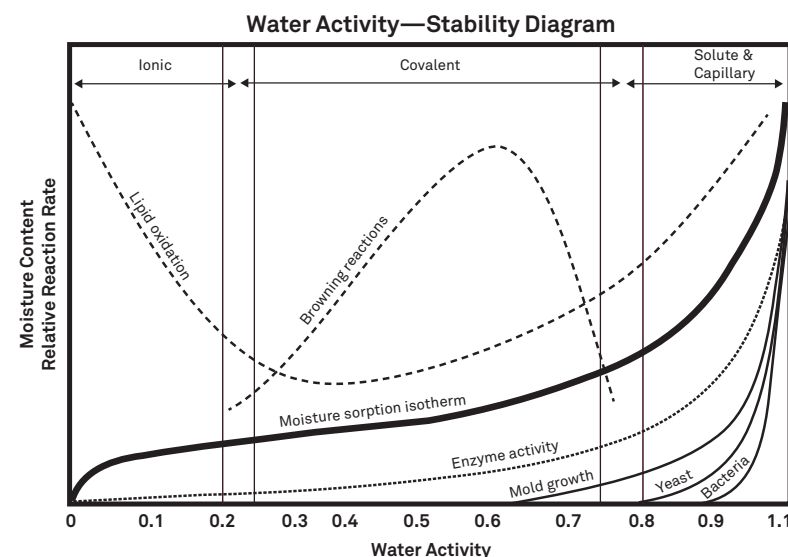


Figure 12 Water activity diagram adapted from Labuza (1976)

Researchers measure the water activity of a system by equilibrating the liquid phase water in the sample with the vapor phase water in the headspace and measuring the relative humidity of the headspace. In the PAWKIT, a sample in a sample cup is placed on a level surface and the PAWKIT is seated on top of the cup, creating a seal. This chamber contains an infrared thermometer and a capacitive humidity sensor. Changes in the electrical capacitance of the polyimide layer of the sensor occur as the relative humidity of the chamber changes. The PAWKIT computes the relative humidity of the headspace

## PAWKIT

### 4.1.2 VERIFY CALIBRATION

Use the following steps to verify the PAWKIT calibration.

**NOTE:** An error code of 9.99 at any time during the process indicates that the sensor has failed and that the instrument needs to be serviced. Refer to Section 4.4 for shipping instructions.

1. Using a vial of the 0.760  $a_w$  NaCl standard, empty the entire contents of the vial into a sample cup.
2. Place the PAWKIT over the sample cup as described in the Section 2.1.2.
3. Press the I button to take a reading.

If it is reading the correct water activity ( $\pm 0.02$ ), the PAWKIT needs no adjustment for this standard. Skip to step 7.

If the first reading was not the correct water activity ( $\pm 0.02$ ), clean the PAWKIT according to the instructions in Section 4.2 and take a second reading.

If the second reading is the correct water activity ( $\pm 0.02$ ), the PAWKIT needs no adjustment at this time. Skip to step 7. If the second reading is not correct, continue to the next step.

4. Press the II button (on the right) once to get the Calibration Mode screen (Figure 13).

Once the reading is finished, the II button (on the right) activates. The II button is only active until the PAWKIT shuts itself off.

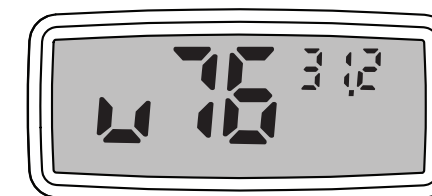


Figure 13 Calibration Mode screen

Figure 13 shows that the PAWKIT is ready to have its calibration adjusted up for the 0.76 standard. The number in the upper right corner indicates the water activity measurement that the PAWKIT just read. Press the II button to scroll through the other selections. They are: u76, d76, u25, d25, Sto, u92, and d92. The u and d before each number stand for up or down adjustment for each standard. The numbers (25, 76, and 92) correspond to the water activity of a verification standard (0.76, 0.25, and 0.92  $a_w$ ). The Sto position stores a reading.

#### EXAMPLE:

If the NaCl reading is lower than it should be, press the II button to scroll to u76 (adjust up for 0.76 standard). If the reading is higher than it should be, scroll to d76 (adjust down for 0.76 standard).

**NOTE:** Scroll feature is continuous, so if desired adjustment screen is passed, keep pressing the II button until cycled back to the correct screen.



## 4. SERVICE

This section describes the calibration and maintenance of the PAWKIT. Troubleshooting solutions and customer service information are also provided.

### 4.1 VERIFICATION AND CALIBRATION

The PAWKIT takes water activity measurements by measuring the change in electrical properties of a special polymer held between two electrodes. Because of the nature of the capacitance humidity sensor, it is important to verify the PAWKIT water activity calibration against known standards to guarantee optimal performance and accuracy. METER recommends verification daily, once per shift, or before each use. METER also recommends annual factory calibration to maintain optimal performance.

#### 4.1.1 VERIFICATION STANDARDS

The PAWKIT uses three calibration standards:

- 6.00 mol/kg NaCl (0.760  $a_w$ )
- 13.41 mol/kg LiCl (0.250  $a_w$ )
- 2.33 mol/kg NaCl (0.920  $a_w$ )

Verification standards are specially prepared, unsaturated salt solutions having a specific molality and water activity value that are accurately measurable. The verification standards that were sent with the initial shipment are very accurate and readily available from METER. The verification standards have been produced under a strict quality assurance regime, and their accuracy is verified by an independent third party instrument. They are very accurate, easy to use, and readily available from METER. Using verification standards to verify accuracy can greatly reduce preparation errors. For these reasons, METER recommends using these standards for the most accurate PAWKIT calibration. The verification standards are shelf-stable for 1 year.

To use a verification standard, remove the twist top and pour the contents into an AQUALAB sample cup. Information about the standard value and molality can be found printed on the outside of the plastic vial. If for some reason METER verification standards are not available, contact [Customer Support](#) for instructions on how to create a verification standard salt solution.

The capacitance sensor can exhibit hysteresis. When a high water activity standard or sample is measured, this may influence future readings. After measuring a high water activity sample, allow 1 h for the sensor to dry. Additionally, desiccant or activated carbon can be used to accelerate the drying process.

**NOTE:** To avoid inaccurate water activity readings, verification standards should be used once immediately after opening and not stored in sample cups for repeated use.

by monitoring the change in electrical capacitance. When the water activity of the sample and the relative humidity of the air are in equilibrium, the measurement of the headspace humidity gives the water activity of the sample.

In addition to equilibrium between the liquid phase water and the vapor phase, the internal equilibrium of the sample is important. If a system is not at internal equilibrium, one might measure a steady vapor pressure (over the period of measurement) which is not the true water activity of the system. An example of this might be a baked good or a multicomponent food. Initially out of the oven, a baked good is not at internal equilibrium; the outer surface is at a lower water activity than the center of the baked good. One must wait a period of time in order for the water to migrate and the system to come to internal equilibrium. It is important to keep in mind that by this definition, water activity is an equilibrium measurement.

The water activity of a sample is influenced by factors that affect the binding of water. These factors include temperature, osmotic, matrix, and pressure effects. Typically, water activity is measured at atmospheric pressure, so only the osmotic, temperature, and matrix effects are important.

#### TEMPERATURE EFFECTS

Temperature plays a critical role in water activity determination. Most critical is the measurement of the difference between sample and the PAWKIT temperature. For water activity measurements to be accurate to 0.02, temperature difference measurements need to be accurate to 0.02 °C. The PAWKIT infrared thermometer measures the temperature of the sample surface. The thermometer is carefully calibrated to minimize temperature errors; however, achieving 0.02 °C accuracy is difficult when temperature differences are large. Most accurate measurements are obtained when the sample is near instrument temperature.

Another effect of temperature on water activity occurs when samples are near saturation. A sample that is close to 1.0  $a_w$  and is warmer than the PAWKIT will cause water to condense within the chamber. This causes errors in the measurement and in subsequent measurements until the condensation disappears. For example, a sample at 0.75  $a_w$  only needs to be 4 °C above the sample chamber temperature to cause condensation to form. For high water activity samples, the operator needs to be aware that condensation can occur if a sample is warmer than the PAWKIT.

The AQUALAB 4TE and TDL have several advantages in having a temperature-controlled chamber. A few major reasons are detailed here.

1. Research purposes.

Researchers can use temperature control to study the effects of temperature on the water activity of a sample, make a comparison of the water activity of different samples independent of temperature, and conduct accelerated shelf-life studies or other water activity studies where temperature control is critical. There are many shelf-life, packaging, and isotherm studies in which temperature control would be very beneficial.

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<p>2. Compliance with government or internal regulations for specific products.</p> <p>Though the water activity of most products varies by less than <math>\pm 0.02</math> per degree Celsius, some regulations require measurement at a specific temperature. The most common specification is 25 °C, though 20 °C is sometimes indicated.</p> <p>3. Minimization of extreme ambient temperature fluctuations.</p> <p>If the environmental and PAWKIT temperatures fluctuate by as much as <math>\pm 5</math> °C daily, water activity readings may vary by <math>\pm 0.01 a_w</math>. Temperature control eliminates variations caused by changes in ambient conditions.</p> <p>The AQUALAB 4TE and TDL models have thermoelectric components installed to allow the instrument to maintain a set chamber temperature.</p> <p>The water activity of the water in a system is influenced by factors that affect the binding of water. They include osmotic, matrix, and pressure effects. Typically water activity is measured at atmospheric pressure, so only the osmotic and matrix effects are important.</p> <p><b>OSMOTIC EFFECTS</b></p> <p>Osmotic effects are well known from biology and physical chemistry. Water is diluted when a solute is added. If this diluted water is separated from pure water by a semipermeable membrane, water tends to move from the pure water side through the membrane to the side with the added solute. If sufficient pressure is applied to the solute-water mixture to just stop the flow, this pressure is a measure of the osmotic potential of the solution. Addition of 1 mol of an ideal solute to 1 kg of water produces an osmotic pressure of 22.4 atm. This lowers the water activity of the solution from 1.0 to 0.98 <math>a_w</math>. For a given amount of solute, increasing the water content of the systems dilutes the solute, decreasing the osmotic pressure, and increasing the water activity. Since microbial cells are high concentrations of solute surrounded by semipermeable membranes, the osmotic effect on the free energy of the water is important for determining microbial water relations and therefore microbe activity.</p> <p><b>MATRIX EFFECTS</b></p> <p>The sample matrix affects water activity by physically binding water within its structure through adhesive and cohesive forces that hold water in pores and capillaries and to particle surfaces. If cellulose or protein were added to water, the energy status of the water would be reduced. Work would need to be done to extract the water from this matrix. This reduction in energy status of the water is not osmotic, because the cellulose or protein concentrations are far too low to produce any significant dilution of water. The reduction in energy is the result of direct physical binding of water to the cellulose or protein matrix by hydrogen bonding and van der Waal forces. At higher water activity levels, capillary forces and surface tension can also play a role.</p>	<p><b>3.3.3 WATER POTENTIAL</b></p> <p>Water activity is closely related to a thermodynamic property called the water potential, or chemical potential (<math>\mu</math>) of water, which is the change in Gibbs free energy (<math>\Delta G</math>) when water concentration changes. Equilibrium occurs in a system when <math>\mu</math> is the same everywhere in the system. Equilibrium between the liquid and the vapor phases implies that <math>\mu</math> is the same in both phases. This means the measured water potential of the vapor phase and can be used to determine the water potential of the liquid phase. Gradients in <math>\mu</math> are driving forces for moisture movement. In an isothermal system, water tends to move from regions of high water potential (high <math>a_w</math>) to regions of low water potential (low <math>a_w</math>). Moisture content is not a driving force for water movement, except in homogeneous materials.</p> <p><b>3.3.4 SORPTION ISOTHERMS</b></p> <p>Changes in water content affect both the osmotic and matrix binding of water in a product. Therefore a relationship exists between the water activity and moisture content. This relationship is called the sorption isotherm and is unique for each product. Besides being unique to each product, the isotherm changes depending on whether it was obtained by drying or wetting the sample. Typically, large safety margins are built into water content specifications to allow for these uncertainties.</p> <p>While the sorption isotherm is often used to infer water activity from moisture content, one could easily go the other direction and infer the moisture content from water activity. This is particularly attractive because water activity can be measured much more quickly than water content. This method gives particularly good precision in the center of the isotherm. In order to infer moisture content from water activity, an isotherm for the particular product is needed. METER can run the isotherm for a fee. Visit <a href="https://metergroup.com/food/services/water-activity-and-isotherm-testing">metergroup.com/food/services/water-activity-and-isotherm-testing</a> for more information.</p>
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