COD3 Plus
Colorimeter

Operator's Manual

1925-MN

Version 1.0

11.07.14

V2

LaMotte

WARNING! This set contains chemicals that may be harmful if misused. Read cautions on individual containers carefully. Not to be used by children except under adult supervision

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GENERAL INFORMATION

■ PACKAGING & DELIVERY

Experienced packaging personnel at LaMotte Company assure adequate protection against normal hazards encountered in transportation of shipments. After the product leaves the manufacturer, all responsibility for its safe delivery is assured by the transportation company. Damage claims must be filed immediately with the transportation company to receive compensation for damaged goods.

Should it be necessary to return the instrument for repair or servicing, pack instrument carefully in a suitable container with adequate packing material. A return authorization number must be obtained from LaMotte Company by calling 1-800-344-3100 or emailing tech@lamotte.com. Attach a letter with the authorization number to the shipping carton which describes the kind of trouble experienced. This valuable information will enable the service department to make the required repairs more efficiently.

■ GENERAL PRECAUTIONS

Before attempting to set up or operate this instrument it is important to read the instruction manual. Failure to do so could result in personal injury or damage to the equipment.

The COD3 Plus Colorimeter should not be stored or used in a wet or corrosive environment. Care should be taken to prevent water or reagent chemicals from wet colorimeter tubes from entering the colorimeter chamber.

NEVER PUT WET TUBES IN COLORIMETER.

■ SAFETY PRECAUTIONS

Read the labels on all LaMotte reagent containers prior to use. Some containers include precautionary notices and first aid information. Certain reagents are considered hazardous substances and are designated with a * in the instruction manual. Material Safety Data Sheets (MSDS) can be found at www.lamotte.com. Read the MSDS before using these reagents. Additional emergency information for all LaMotte reagents is available 24 hours a day from the Poison Control Center listed in the front of the phone book or by contacting the 24 hour emergency line for ChemTel 1-800-255-3924 (USA, Canada, Puerto Rico); locations outside the North American Continent 813-248-0585 (call collect). Be prepared to supply the name and four-digit LaMotte code number found on the container label or at the top of the MSDS or in the contents list of the procedure. LaMotte reagents are registered with a computerized poison control information system available to all local poison control centers.

Keep equipment and reagent chemicals out of the reach of young children.

■ LIMITS OF LIABILITY

Under no circumstances shall LaMotte Company be liable for loss of life, property, profits, or other damages incurred through the use or misuse of its products.

■ WARRANTY

LaMotte Company warrants this instrument to be free of defects in parts and workmanship for 2 years from the date of shipment. If it should become necessary to return the instrument for service during or beyond the warranty period, contact our Technical Service Department at 1-800-344-3100 or tech@lamotte.com for a return authorization number or visit www.lamotte.com for troubleshooting help. The sender is responsible for shipping charges, freight, insurance and proper packaging to prevent damage in transit. This warranty does not apply to defects resulting from action of the user such as misuse, improper wiring, operation outside of specification, improper maintenance or repair, or unauthorized modification. LaMotte Company specifically disclaims any implied warranties or merchantability or fitness for a specific purpose and will not be liable for any direct, indirect, incidental or consequential damages. LaMotte Company's total liability is limited to repair or replacement of the product. The warranty set forth above is inclusive and no other warranty, whether written or oral, is expressed or implied.

■ REGISTER YOUR METER

To register your meter with the LaMotte Service Department, go to www.lamotte.com and choose SUPPORT on the top navigation bar.

■ SPECIFICATIONS

INSTRUMENT TYPE: Colorimeter

Readout	160 x 100 backlit LCD, 20 x 6 line graphical display
Wavelengths	428 nm, 635 nm
Wavelength Accuracy	±2% FS
Readable Resolution	Determined by reagent system
Wavelength Bandwidth	10 nm typical
Photometric Range	–2 to +2 AU
Photometric Precision	± 0.001 AU at 1.0 AU
Photometric Accuracy	±0.005 AU at 1.0 AU
Sample Chamber	Accepts 25 mm diameter flat-bottomed test tubes, 10 mm square cuvettes, 16 mm COD test tubes
Light Sources	2 LEDs
Detectors	2 silicon photodiodes
Modes	Pre-programmed tests, absorbance, %T
Pre-Programmed Tests	YES, with automatic wavelength selection
User Defined Tests	Up to 25 user tests can be input
Languages	English, Spanish, French, Portuguese, Italian, Chinese, Japanese
USB Port	Mini B
Power Requirements	USB wall adapter, USB computer connection or lithium ion rechargeable battery
Battery	Charge Life: Approximately 380 tests with backlight on to 1000 tests with backlight off. (Signal averaging disabled). Battery Life: Approximately 500 charges.
Electrical Rating	Provided on nameplate label
Data Logger	500 test results stored for download to a PC
Waterproof	IP67 with USB port plug in place
Dimensions (LxWxH)	3.5 x 7.5 x 2.5 inches, 8.84 x 19.05 x 6.35 cm
Weight	13 oz, 362 g (meter only)

■ STATISTICAL & TECHNICAL DEFINITIONS RELATED TO PRODUCT SPECIFICATIONS

Method Detection Limit (MDL): "The method detection limit (MDL) is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte."[1] Note that, "As Dr. William Horwitz once stated, 'In almost all cases when dealing with a limit of detection or limit of determination, the primary purpose of determining that limit is to stay away from it.'"[2]

Accuracy: Accuracy is the nearness of a measurement to the accepted or true value.[3] The accuracy can be expressed as a range, about the true value, in which a measurement occurs (i.e. ±0.5 ppm). It can also be expressed as the % recovery of a known amount of analyte in a determination of the analyte (i.e. 103.5 %).

Resolution: Resolution is the smallest discernible difference between any two measurements that can be made.[4] For meters this is usually how many decimal places are displayed. (i.e. 0.01). Note that the resolution many change with concentration or range. In some cases the resolution may be less than the smallest interval, if it is possible to make a reading that falls between calibration marks. A word of caution, that resolution has very little relationship to accuracy or precision. The resolution will always be less than the accuracy or precision but it is not a statistical measure of how well a method of analysis works. The resolution can be very, very good and the accuracy and precision can be very bad! This is not a useful measure of the performance of a test method.

Repeatability: Repeatability is the within-run precision.[5] A run is a single data set, from set up to clean up. Generally, one run occurs on one day. However, for meter calibrations, a single calibration is considered a single run or data set, even though it may take 2 or 3 days.

Reproducibility: Reproducibility is the between-run precision.[6]

Detection Limit (DL): The detection limit (DL) for the 2020we/wi is defined as the minimum value or concentration that can be determined by the meter, which is greater than zero, independent of matrix, glassware, and other sample handling sources of error. It is the detection limit for the optical system of the meter.

[1] CFR 40, part 136, appendix B

[2] Statistics in Analytical Chemistry: Part 7 – A Review, D. Coleman and L Vanatta, American Laboratory, Sept 2003, P. 31.

[3] Skoog, D.A., West, D. M., *Fundamental of Analytical Chemistry*, 2nd ed., Holt Rinehart and Winston, Inc, 1969, p. 26.

[4] Statistics in Analytical Chemistry: Part 7 – A Review, D. Coleman and L Vanatta, American Laboratory, Sept 2003, P. 34.

[5] Jeffery G. H., Basset J., Mendham J., Denney R. C., *Vogel's Textbook of*

Quantitative Chemical Analysis, 5th ed., Longman Scientific & Technical, 1989, p. 130.

[6] Jeffery G. H., Basset J., Mendham J., Denney R. C., *Vogel's Textbook of Quantitative Chemical Analysis*, 5th ed., Longman Scientific & Technical, 1989, p. 130

■ CONTENTS AND ACCESSORIES

CONTENTS

COD3 Plus Colorimeter

Test Tubes, with Caps

COD/UDV Adapter

USB Wall Adapter

USB Cable

COD3 Plus Colorimeter Quick Start Guide

COD3 Plus Colorimeter Manual

ACCESSORIES

Test Tubes, with Caps	Code 0290-6
Replacement Chamber	Code 3-0038
USB Cable	Code 1720
USB Wall Adapter	Code 1721
COD/UDV Adapter	Code 1724
Car Charger	Code 5-0132
SMARTLink3 Program (CD)	Code 1901-CD
Small Field Carrying Case (37.5 27.5 x 13.75 cm)	Code 1910-GCS150
Large Field Carrying Case (45 x 32.5 x 20 cm)	Code 1910-GCS440

■ EPA COMPLIANCE

The COD3 Plus Colorimeter is an EPA-Accepted instrument. EPA-Accepted means that the instrument meets the requirements for instrumentation as found in test procedures that are approved for the National Primary Drinking Water Regulations (NPDWR) or National Pollutant Discharge Elimination System (NPDES) compliance monitoring programs. EPA-Accepted instruments may be used with approved test procedures without additional approval.

■ CE COMPLIANCE

The COD3 Plus Colorimeter has earned the European CE Mark of Compliance for electromagnetic compatibility and safety. The Declaration of Conformity for the COD3 Plus Colorimeter is available at www.lamotte.com.

■ IP67 CERTIFICATION

The COD3 Plus meets IP67 standards for protection against dust and immersion only when the USB port plug is in place. Documentation is available at www.lamotte.com.

WATER SAMPLING FOR CHEMICAL ANALYSIS

Taking Representative Samples

The underlying factor to be considered for any type of water sampling is whether or not the sample is truly representative of the source. To properly collect a representative sample:

- Sample as frequently as possible.
- Collect a large sample or at least enough to conduct whatever tests are necessary.
- Make a composite sample for the same sampling area.
- Handle the sample in such a way as to prevent deterioration or contamination before the analysis is performed.
- Perform analysis for dissolved gases such as dissolved oxygen, carbon dioxide, and hydrogen sulfide immediately at the site of sampling. Samples for testing these factors, as well as samples for pH, cannot be stored for later examination.
- Make a list of conditions or observations which may affect the sample. Other considerations for taking representative samples are dependent upon the source of the sample. Taking samples from surface waters involves different considerations than taking samples from impounded and sub-surface waters.

Sampling of Open Water Systems

Surface waters, such as those found in streams and rivers, are usually well mixed. The sample should be taken downstream from any tributary, industrial or sewage pollution source. For comparison purposes samples may be taken upstream and at the source of the pollution before mixing.

In ponds, lakes, and reservoirs with restricted flow, it is necessary to collect a number of samples in a cross section of the body of water, and where possible composite samples should be made to ensure representative samples.

To collect samples from surface waters, select a suitable plastic container with a tight fitting screw cap. Rinse the container several times with the sample to be tested, then immerse the container below the surface until it is filled to overflowing and replace the cap. If the sample is not to be tested immediately, pour a small part of the sample out and reseal. This will allow for any expansion. Any condition which might affect the sample should be listed.

Sub-surface sampling is required to obtain a vertical profile of streams, lakes, ponds, and reservoirs at specific depths. This type of sampling requires more sophisticated sampling equipment.

For dissolved oxygen studies, or for tests requiring small sample sizes, a Water

Sampler (LaMotte Code 1060) will serve as a subsurface or in-depth sampler. This weighted device is lowered to the sampling depth and allowed to rest at this depth for a few minutes. The water percolates into the sample chamber displacing the air which bubbles to the surface. When the bubbles cease to rise, the device has flushed itself approximately five times and it may be raised to the surface for examination. The inner chamber of the sampling device is lifted out and portions of the water sample are carefully dispensed for subsequent chemical analysis.

A Snap-Plunger Water Sampler (LaMotte Code 1077) is another "in-depth" sampling device which is designed to collect large samples which can be used for a multitude of tests. Basically, this collection apparatus is a hollow cylinder with a spring loaded plunger attached to each end. The device is cocked above the surface of the water and lowered to the desired depth. A weighted messenger is sent down the calibrated line to trip the closing mechanism and the plungers seal the sample from mixing with intermediate layers as it is brought to the surface. A special drain outlet is provided to draw off samples for chemical analysis.

Sampling of Closed System

To obtain representative samples from confined water systems, such as pipe lines, tanks, vats, filters, water softeners, evaporators and condensers, different considerations are required because of chemical changes which occur between the inlet and outlet water. One must have a basic understanding of the type of chemical changes which occur for the type of equipment used. Also, consideration should be given to the rate of passage and retaining time for the process water.

Temperature changes play an important part in deciding exactly what test should be performed. Process water should be allowed to come to room temperature, 20–25°C, before conducting any tests.

When drawing off samples from an outlet pipe such as a tap, allow sample to run for several minutes, rinsing the container several times before taking the final sample. Avoid splashing and introduction of any contaminating material.

■ FILTRATION

When testing natural waters that contain significant turbidity due to suspended solids and algae, filtration is an option. Reagent systems, whether EPA, Standard Methods, LaMotte or any others, will generally only determine dissolved constituents. Both EPA and Standard Methods suggest filtration through a 0.45 micron filter membrane, to remove turbidity, for the determination of dissolved constituents.** To test for total constituents, organically bound and suspended or colloidal materials, a rigorous high temperature acid digestion is necessary.

**LaMotte offers a filtering apparatus: syringe assembly (Code 1050) and membrane filters, 0.45 micron, (Code 1103).

■ AN INTRODUCTION TO COLORIMETRIC ANALYSIS

Most test substances in water are colorless and undetectable to the human eye. To test for their presence we must find a way to “see” them. The COD3 Plus Colorimeter can be used to measure any test substance that is itself colored or can be reacted to produce a color. In fact a simple definition of colorimetry is “the measurement of color” and a colorimetric method is “any technique used to evaluate an unknown color in reference to known colors”. In a colorimetric chemical test the intensity of the color from the reaction must be proportional to the concentration of the substance being tested. Some reactions have limitations or variances inherent to them that may give misleading results. Many such interferences are discussed with each particular test instruction. In the most basic colorimetric method the reacted test sample is visually compared to a known color standard. However, accurate and reproducible results are limited by the eyesight of the analyst, inconsistencies in the light sources, and the fading of color standards.

To avoid these sources of error, a colorimeter can be used to photoelectrically measure the amount of colored light absorbed by a colored sample in reference to a colorless sample (blank).

White light is made up of many different colors or wavelengths of light. A colored sample typically absorbs only one color or one band of wavelengths from the white light. Only a small difference would be measured between white light before it passes through a colored sample versus after it passes through a colored sample. The reason for this is that the one color absorbed by the sample is only a small portion of the total amount of light passing through the sample. However, if we could select only that one color or band of wavelengths of light to which the test sample is most sensitive, we would see a large difference between the light before it passes through the sample and after it passes through the sample.

The COD3 Plus Colorimeter passes one of four colored light beams through one of four optical filters which transmits only one particular color or band of wavelengths of light to the photodectector where it is measured. The difference in the amount of colored light transmitted by a colored sample is a measurement of the amount of colored light absorbed by the sample. In most colorimetric tests the amount of colored light absorbed is directly proportional to the concentration of the test factor producing the color and the path length through the sample. However, for some tests the amount of colored light absorbed is inversely proportional to the concentration.

The choice of the correct wavelength for testing is important. It is interesting to note that the wavelength that gives the most sensitivity (lower detection limit) for a test factor is the complementary color of the test sample. For example the Nitrate-Nitrogen test produces a pink color proportional to the nitrate-nitrogen concentration in the sample (the greater the nitrate-nitrogen concentration, the darker the pink color). A wavelength in the green region should be selected to analyze this sample since a pinkish-red solution absorbs mostly green light.

■ REAGENT BLANK

Some tests will provide greater accuracy if a reagent blank is determined to compensate for any color or turbidity resulting from the reagents themselves. A reagent blank is performed by running the test procedure on demineralized or deionized water. Use sample water to SCAN BLANK. Insert the reacted reagent blank in the colorimeter chamber and select SCAN SAMPLE. Note result of reagent blank. Perform the tests on the sample water as described. Subtract results of reagent blank from all subsequent test results. NOTE: Some tests require a reagent blank to be used to SCAN BLANK.

■ COLORIMETER TUBES AND CHAMBER

Colorimeter tubes and colorimeter chambers which have been scratched through excessive use should be discarded and replaced with new ones. Dirty tubes should be cleaned on both the inside and outside. Fingerprints on the exterior of the tubes can cause excessive light scattering and result in errors. Handle the tubes carefully, making sure the bottom half of the tube is not handled.

LaMotte Company makes every effort to provide high quality colorimeter tubes. However, wall thicknesses and diameter of tubes may still vary slightly. This may lead to slight variations in results (e.g. if a tube is turned while in the sample chamber, the reading will likely change slightly). To eliminate this error put the tubes into the sample chamber with the same orientation every time.

The tubes that are included with the colorimeter have an index mark to facilitate this. If possible, use the same tube to SCAN BLANK and SCAN SAMPLE.

■ METER CARE

The optical system of the COD3 Plus must be kept clean and dry for optimal performance. Dry the colorimeter tubes before placing them in the chamber to avoid introducing moisture. For best results store the instrument in a area that is dry and free from aggressive chemical vapors.

■ SELECTING AN APPROPRIATE WAVELENGTH

The most appropriate wavelength to use when creating a calibration curve is usually the one which gives the greatest change from the lowest reacted standard concentration to the highest reacted standard concentration. However, the absorbance of the highest reacted standard concentration should never be greater than 2.0 absorbance units. Scan the lowest and highest reacted standards at different wavelengths using the absorbance mode to find the wavelength which gives the greatest change in absorbance without exceeding 2.0 absorbance units. Use this wavelength to create a calibration curve.

Below is a list of suggested wavelengths for the color of the reacted samples. Use these as a starting point.

Sample Color	Wavelength Range
Yellow	428
Pink	525
Red	568
Green and Blue	635

NOTE: Available wavelengths in the COD3 Plus are 428 nm and 635 nm.

■ CALIBRATION

As with all pre-calibrated meters, it is highly recommended, even if not required by regulations, that the user periodically verify the performance of the meter by running standards with a predetermined concentration. Results outside of specification are an indication that the meter needs to be adjusted. This can be done following the user calibration described on page 32. If the user calibration fails to properly adjust the meter then the meter should be returned to LaMotte Company for recalibration. (See page 68).

■ CALIBRATION CURVES

The COD3 Plus Colorimeter contains tests for the LaMotte reagent systems. The first step in using a non-LaMotte reagent system with your COD3 Plus Colorimeter is to create a calibration curve for the reagent system. To create a calibration curve, prepare standard solutions of the test factor and use the reagent system to test the standard solutions with the COD3 Plus Colorimeter. Select a wavelength for the test as described above.

Plot the results (in ABS or %Transmittance) versus concentration to create a calibration curve. The calibration curve may then be used to identify the concentration of an unknown sample by testing the unknown, reading Absorbance or %T, and finding the corresponding concentration from the curve. The linear range of the reagent system can be determined and this information can be used to input a User Test into the COD3 Plus Colorimeter (see Edit User Tests, page 39).

PROCEDURE

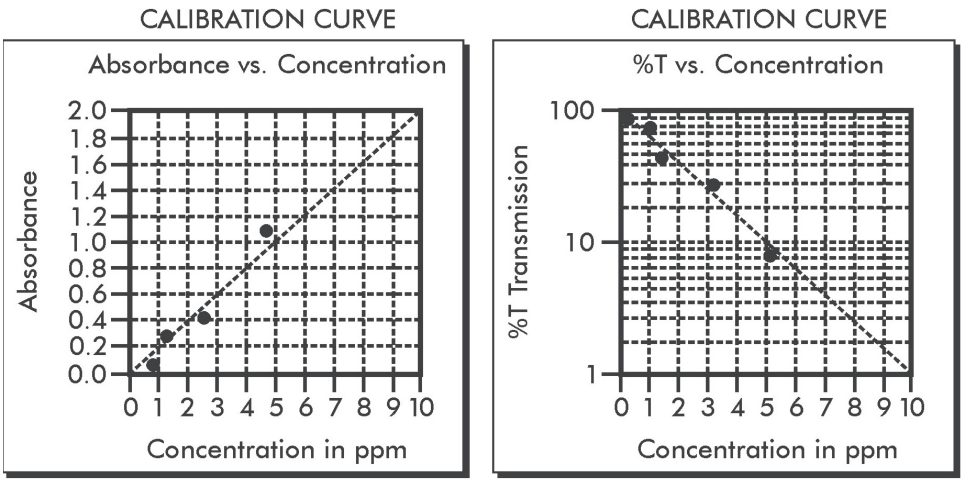
Prepare 5 or 6 standard solutions of the factor being tested. The concentration of these standards should be evenly distributed throughout the range of the reagent system, and should include a 0 ppm standard (distilled water). For instance, the solutions could measure 0, 10%, 30%, 50%, 70%, and 90% of the system's maximum range.

1. Turn on the COD3 Plus Colorimeter. Select the appropriate wavelength from the absorbance mode. Be sure to select the appropriate wavelength for the color produced by the reagent system.

2. Use the unreacted 0 ppm standard to standardize the colorimeter by using it to scan blank.
3. Following the individual reagent system instructions, react each standard solution beginning with 0 ppm. Continue with standards in increasing concentration. Record the reading and the standard solution concentration on a chart. Readings can be recorded as percent transmittance (%T) or absorbance (A).
4. Plot results on graph paper or computer using any available plotting program. If results are as %T versus concentration, semilog graph paper must be used. Plot the standard solution concentrations on the horizontal, linear axis, and the %T on the vertical, logarithmic axis. If results are as absorbance versus standard solution concentration, simple linear graph paper can be used. Plot the standard solution concentration on the horizontal axis, and the absorbance on the vertical axis.
5. After plotting the results, draw a line, or curve, of best fit through the plotted points. The best fit may not connect the points. There should be approximately an equal number of points above the curve as below the curve. Some reagent systems will produce a straight line, while others produce a curve. Many computer spreadsheet programs can produce the curve of best fit by regression analysis of the standard solution data.

NOTE: Only reagent systems which produce a straight line can be used for a User Test.

A sample of each type of graph appears below:



PREPARING DILUTE STANDARD SOLUTIONS

Standard solutions should be prepared to create a calibration curve. Standard solutions can be prepared by diluting a known concentrated standard by specified amounts. A chart or computer spreadsheet can be created to determine the proper dilutions. Use volumetric flasks and volumetric pipets for all dilutions.

1. In Column A – Record the maximum concentration of test as determined by the range and path length.
2. In Column B – Record the percent of the maximum concentration the standard solution will be.
3. In Column C – Calculate the final concentration of the diluted standard solutions by multiplying the maximum concentration (In Column A) by the % of maximum concentration divided by 100. ($C = A \times {}^{B}/_{100}$).
4. In Column D – Record the final volume of the diluted sample (i.e. volume of volumetric flask).
5. In Column E – Record the concentration of the original standard.
6. In Column F – Calculate the milliliters of original standard required ($F = (C \times {}^{D}/_{E})$).

A sample chart appears below:

A	B	C = A x $^{B}/_{100}$	D	E	F = C x $^{D}/_{E}$
Maximum concentration of test	% of Maximum concentration	Final concentration of Diluted Standard	Volume of Standard	Concentration of Original Standard	mL of Original Standard Required
10.0 ppm	90	9.0 ppm	100 mL	1000 ppm	0.90 mL
10.0 ppm	70	7.0 ppm	100 mL	1000 ppm	0.70 mL
10.0 ppm	50	5.0 ppm	100 mL	1000 ppm	0.50 mL
10.0 ppm	30	3.0 ppm	100 mL	1000 ppm	0.30 mL
10.0 ppm	10	1.0 ppm	100 mL	1000 ppm	0.10 mL
10.0 ppm	0	0 ppm	100 mL	1000 ppm	0 mL

■ STANDARD ADDITIONS

A common method to check the accuracy and precision of a test is by standard additions. In this method a sample is tested to determine the concentration of the test substance. A second sample is then "spiked" by the addition of a known quantity of the test substance. The second sample is then tested. The determined concentration of the spiked sample should equal the concentration of the first plus the amount added with the spike. The procedure can be repeated with larger and larger "spikes." If the determined concentrations do not equal the concentration of the sample plus that added with the "spike", then an interference may exist.

For example, a 10.0 mL water sample was determined to contain 0.3 ppm iron. To a second 10.0 mL sample, 0.1 mL of 50 ppm iron standard was added. The concentration of iron due to the "spike" was (0.10 mL x 50 ppm)/10.0 mL = 0.50 ppm. The concentration of iron determined in the spiked sample should be 0.3 + 0.5 = 0.8 ppm iron. (Note: any error due to the increased volume from the "spike" is negligible).

LaMotte offers a line of calibration standards which can be used to generate calibration curves and perform standard additions.

■ SAMPLE DILUTION TECHNIQUES & VOLUMETRIC MEASUREMENTS

If a test result using the COD3 Plus Colorimeter gives an over range message then the the sample must be diluted. The test should be repeated on the diluted sample to obtain a reading which is in the concentration range for the test. (Note: This is not true for colorimetric determination of pH.)

Example:

Measure 5 mL of the water sample into a graduated cylinder. Add demineralized water until the cylinder is filled to the 10 mL line. The sample has been diluted by one-half, and the dilution factor is therefore 2. Perform the test procedure, then multiply the resulting concentration by 2 to obtain the test result.

The following table gives quick reference guidelines on dilutions of various proportions. All dilutions are based on a 10 mL volume, so several dilutions will require small volumes of the water sample. Graduated pipets should be used for all dilutions.

Size of Sample	Deionized Water to Bring Volume to 10 mL	Multiplication Factor
10 mL	0 mL	1
5 mL	5 mL	2
2.5 mL	7.5 mL	4
1 mL	9 mL	10
0.5 mL	9.5 mL	20

If the above glassware is not available, dilutions can be made with the colorimeter tube. Fill the tube to the 10 mL line with the sample then transfer it to another container. Add 10 mL volumes of demineralized water to the container and mix. Transfer back 10 mL of the diluted sample to the tube and follow the test procedure. Continue diluting and testing until a reading, which is in the concentration range for the test, is obtained. Be sure to multiply the concentration found by the dilution factor (the number of total 10 mL volumes used).

Example:

10 mL of sample is diluted with three 10 mL volumes of demineralized water; the dilution factor is four.

■ INTERFERENCES

LaMotte reagent systems are designed to minimize most common interferences. Each individual test instruction discusses interferences unique to that test. Be aware of possible interferences in the water being tested.

The reagent systems also contain buffers to adjust the water sample to the ideal pH for the reaction. It is possible that the buffer capacity of the water sample may exceed the buffer capacity of the reagent system and the ideal pH will not be obtained. If this is suspected, measure the pH of a reacted distilled water reagent blank using a pH meter. This is the ideal pH for the test. Measure the pH of a reacted water sample using the pH meter. If the pH is significantly different from the ideal value, the pH of the sample should be adjusted before testing.

Interferences due to high concentration of the substance being tested, can be overcome by sample dilution (see page 19)

■ STRAY LIGHT INTERFERENCE

When scanning samples in 16 mm tubes, such as COD, the sample chamber lid can not be closed. The COD adapter minimizes stray light. To further reduce stray light interference, do not scan sample in direct sunlight.

OPERATION OF THE COD3 PLUS COLORIMETER

■ OVERVIEW

The COD3 Plus is a portable, microprocessor controlled, direct reading colorimeter. It has a graphical liquid crystal display and 6 button keypad. These allow the user to select options from the menu driven software, to directly read test results or to review stored results of previous tests in the data logger. The menus can be displayed in seven different languages.

The test library consists of 29 LaMotte tests and 25 “User Tests”. The LaMotte tests are precalibrated for LaMotte reagent systems.The colorimeter displays the result of these tests directly in units of concentration. The 25 “User Tests” may be used to enter additional calibrations. All of these tests may be arranged in any of 3 sequences. These sequences can be modified a limitless number of times to meet changing testing needs.

The optics feature 2 different colored LEDs. Each LED has a corresponding silicon photoiode with an integrated interference filter. The interference filters select a narrow band of light from the corresponding LED for the colorimetric measurements. The microporcessor automatically selects the correct LED/ photodiode combination for the test.

A USB wall adapter, USB computer connection or lithium battery powers the COD3 Plus.

A USB port on the back of the meter allows an interface of the meter with a Windows-based computer for real-time data acquisition and data storage using a PC. The COD3 Plus may be interfaced with any Windows-based computer by using the LaMotte SMARTLink3 Program.

■ COMPONENTS

Figure 1 shows a diagram of the COD3 Plus Colorimeter and its components.

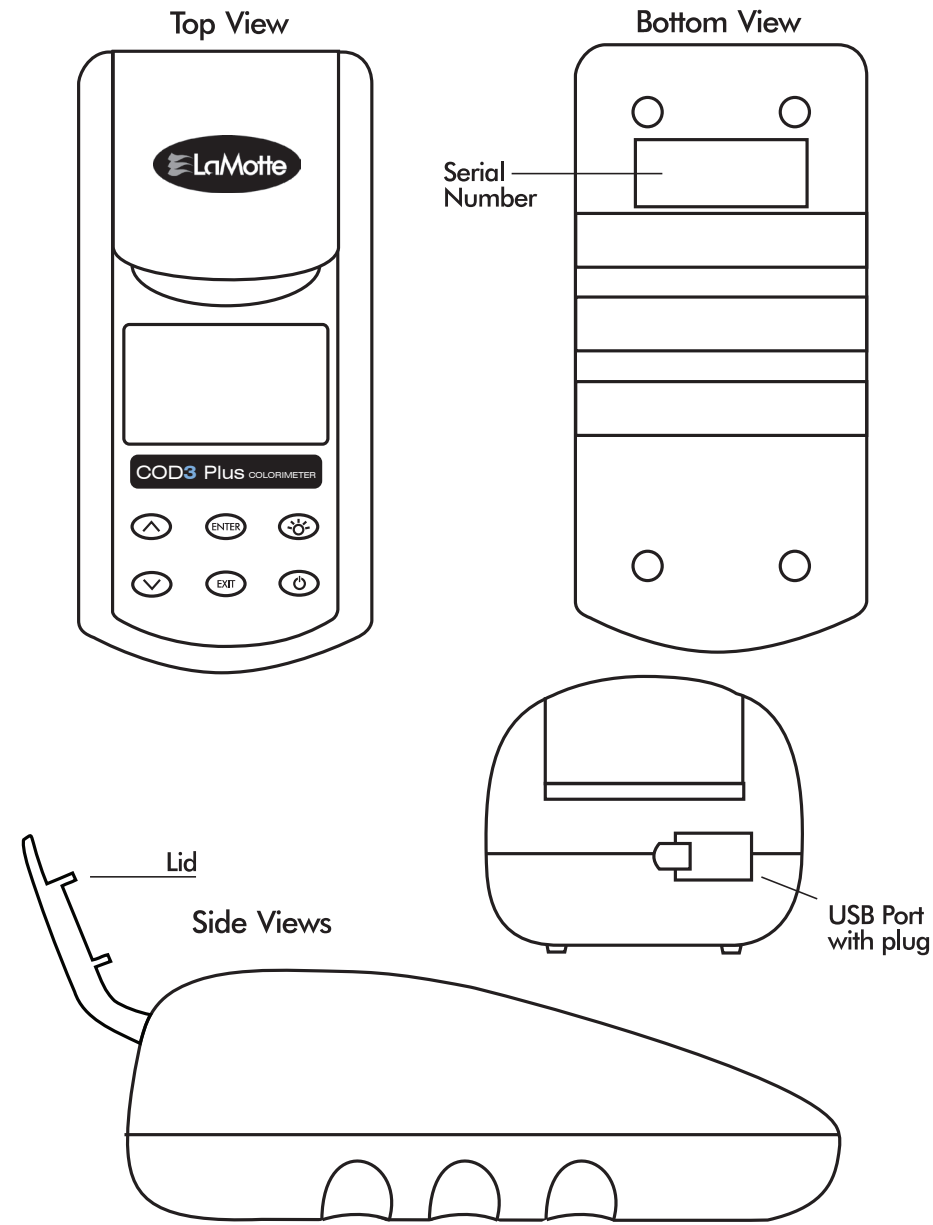


Figure 1

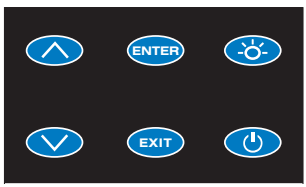
GENERAL OPERATING PROCEDURES

The operation of the COD3 Plus Colorimeter is controlled by a microprocessor. The microprocessor is programmed with menu driven software. A menu is a list of choices. This allows a selection of various tasks for the colorimeter to perform, such as, scan blank, scan sample, and edit test sequences. The keypad is used to make menu selections which are viewed in the display. There are three selections accessible from the Main Menu: Testing Menu, Editing Menu and Run PC Link.

■ THE KEYPAD

The keypad has 6 buttons which are used to perform specific tasks.

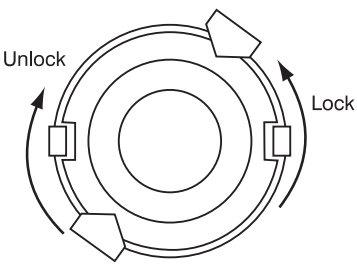
	This button will scroll up through a list of menu selections.
	The button is used to select choices in a menu viewed in the display.
	This button controls the backlight on the display.
	This button will scroll down through a list of menu selections.
	This button exits to the previous menu.
	This button turns the meter on or off.



■ SAMPLE HOLDERS

The sample chamber is designed for 25 mm round tubes. An adapter to hold 16 mm COD tubes and 1 cm square UDV cuvettes is included.

Position the COD/UDV Adapter (Code 1724) so that the notches in the adapter fit around the posts on the chamber. Turn the adapter counterclockwise until the arrows are at the top and bottom of the chamber and the adapter is locked into place. Turn the adapter clockwise to unlock the adapter and remove it from the chamber.

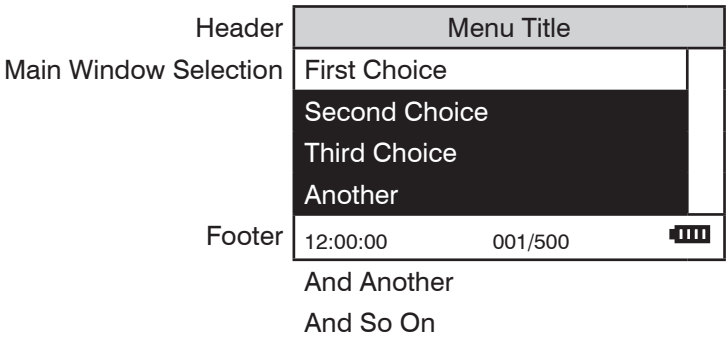


■ THE DISPLAY & THE MENUS

The display allows menu selections to be viewed and selected. These selections instruct the COD3 Plus to perform specific tasks. The menus are viewed in the display using two general formats that are followed from one menu to the next. Each menu is a list of choices or selections.

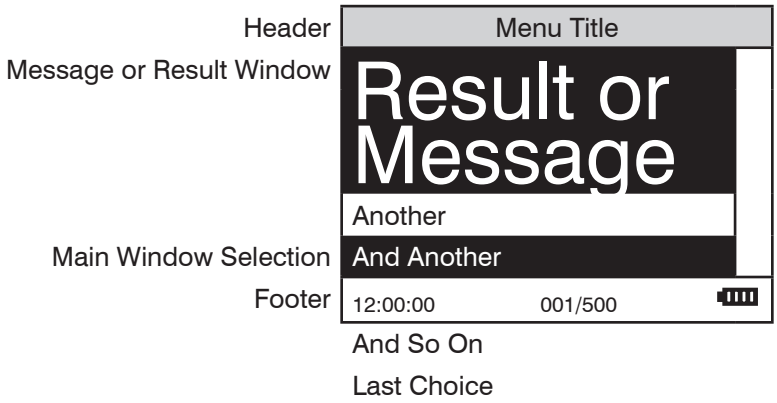
The display has a header line at the top and a footer line at the bottom. The header displays the title of the current menu. The footer line displays the time and the date, the data logger status and the battery status. The menu selection window is in the middle of the display between the header and the footer.

The menu selection window displays information in two general formats. In the first format only menu selections are displayed. Up to 4 lines of menu selections may be displayed. If more selections are available they can be viewed by pressing the arrow buttons to scroll the other menu selections into the menu selection window. Think of the menu selections as a vertical list in the display that moves up or down each time an arrow button is pressed. Some menus in the COD3 Plus are looping menus. The top and bottom menu choices are connected in a loop. Scrolling down past the bottom of the menu will lead to the top of the menu. Scrolling up past the top of the menu will lead to the bottom of the menu.



A light bar will indicate the menu choice. As the menu is scrolled through, the light bar will highlight different menu choices. Pressing the ENTER button will select the menu choice that is indicated by the light bar.

In the second format the menu choice window takes advantage of the graphical capabilities of the display. Large format graphic information, such as test results or error messages or the LaMotte logo is displayed. The top two lines of the display are used to display information in a large, easy to read format. The menus work in the same way as previously described but two lines of the menu are visible at the bottom of the display.



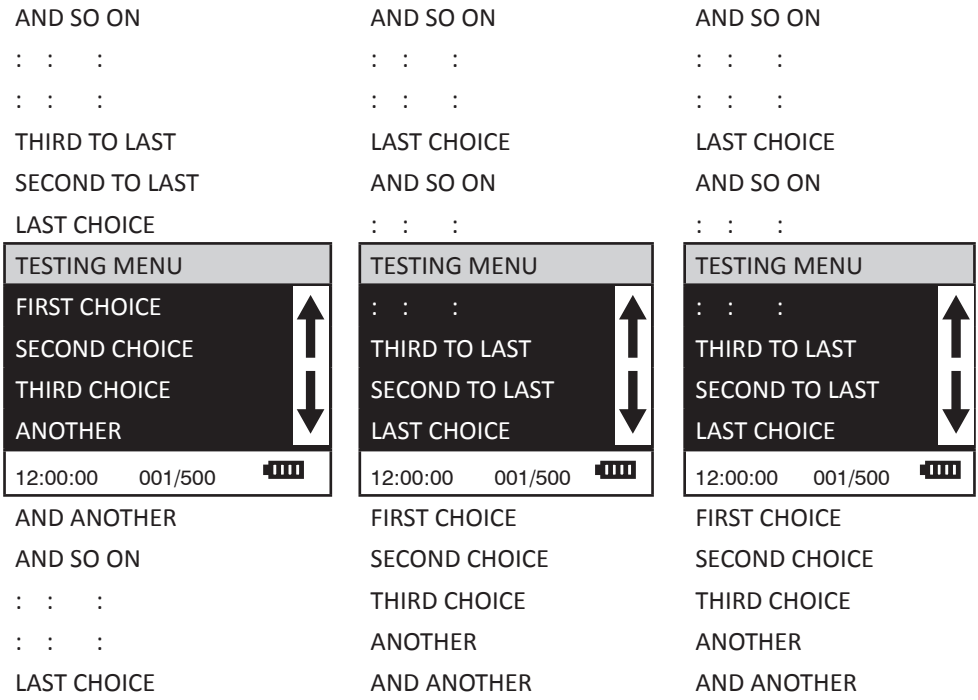
As described previously, the EXIT button allows an exit or escape from the current menu and a return to the previous menu. This allows a rapid exit from an inner menu to the main menu by repeatedly pushing the EXIT button. Pushing at any time will turn the COD3 Plus off.

The display may show the following messages:

	Battery Status
	More choices are available and can be viewed by scrolling up and/or down through the display.
Header	Identifies the current menu and information on units and reagent systems if applicable.
Footer	In the data logging mode the number of the data point is displayed and the total number of data points in the memory will be shown. The footer also shows current time and battery status

■ LOOPING MENUS

Long menus, such as All Tests, incorporate a looping feature which allows the user to quickly reach the last choice in the menu from the first choice. In a looping menu the last choices in the menu are above the first choice and scrolling upward moves through the menu in reverse order. Scrolling downward moves through the menu from first choice to last but the menu starts over following the last choice. So all menu choices can be reached by scrolling in either direction. The diagrams below demonstrate a looping menu.

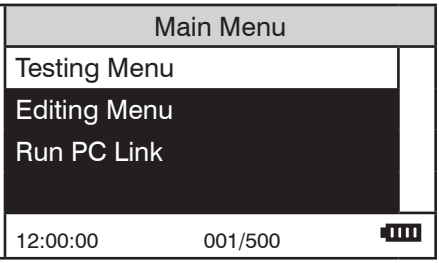


TESTING

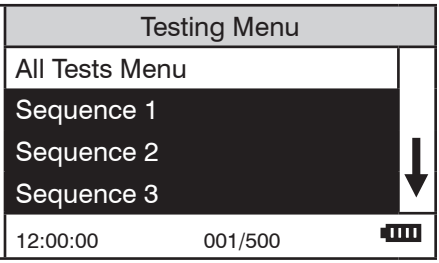
■ TESTING MENU

The Testing Menu is used to run all LaMotte pre-programmed tests, User Tests and Absorbance tests at one of two wavelengths. Testing from any of three sequences can also be done.

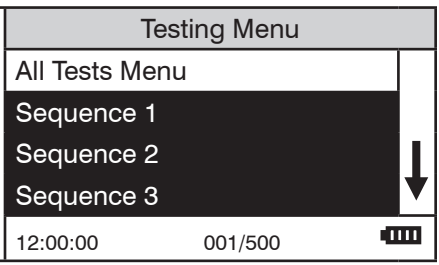
1. Press and briefly hold ⏻ to turn the meter on. The LaMotte logo screen will appear for about 3 seconds and the **Main Menu** will appear.



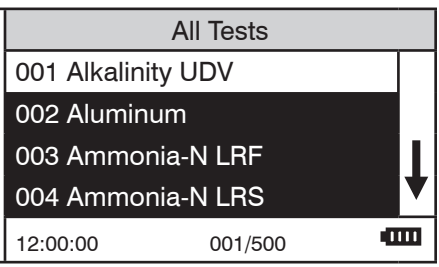
2. Press ENTER to select **Testing Menu**.



3. Press ^ or v to scroll to desired option. **All Tests** contains all of the available pre-programmed tests. The three sequences have user selected tests. Absorbance has %T/ABS tests.



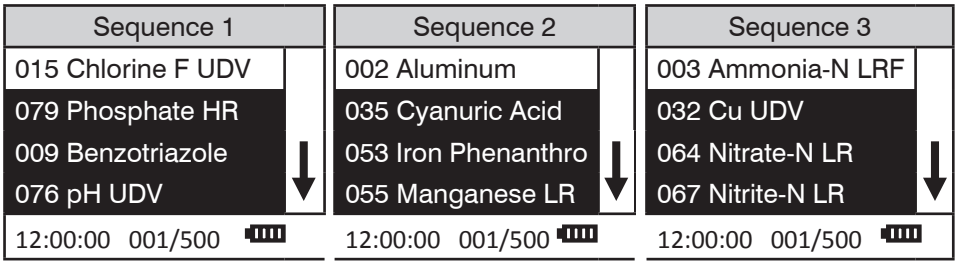
4. Press ENTER to select the option.



■ TEST SEQUENCES

Sequence 1, Sequence 2, And Sequence 3 are alterable sequences. They may be edited using the Editing Menu. Any of the LaMotte pre-programmed tests or User Tests may be placed in these sequences in whatever testing order that is preferred. Some examples of typical sequences are given below.

NOTE: Test in the examples may not be included in the COD3 Plus.



061 Molybdenum HR	064 Nitrate-N LR	074 pH PR
086 Silica HR	067 Nitrite-N LR	078 Phosphate LR
045 Hydrazine	077 Phenol	085 Silica LR
032 Cu UDV	078 Phosphate LR	
051 Iron Bipyridyl	090 Sulfide LR	

These alterable sequences allow a series of tests to be setup that are run frequently. The order of the individual tests in the sequence is determined by the user. After running a test, press ENTER to select the next test in the sequence. Continue this pattern until the entire sequence has been completed.

All Tests is a fixed sequence containing the LaMotte pre-programmed tests, User Tests, and Absorbance tests.
Modification of the alterable sequences is accomplished through the Editing Menu. This menu is explained in greater detail in Editing Menu (p. 39).

Pressing EXIT while in a sequence menu will escape back to the Testing Menu.

Pressing ⏻ the at any time will turn the colorimeter off.

■ GENERAL TESTING PROCEDURES

The following are some step by step examples of how to run tests from the Testing Menu. These test procedures are designed to be used with LaMotte SMART Reagent Systems.

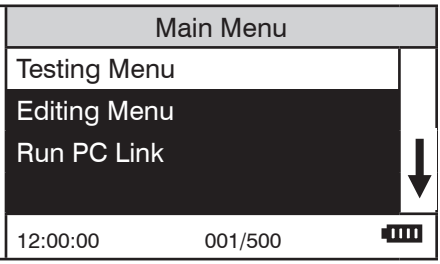
LaMotte Company continuously updates the list of pre-programmed tests as the calibrations become available. Pre-programmed calibrations can be added to the COD3 Plus Colorimeter in the field. A Windows-based computer running a Windows Operating System is required.

Call LaMotte Technical Services at 1-800-344-3100 (410-778-3100 outside the USA) or email at tech@lamotte.com for a current list of available calibrations and downloading instructions.

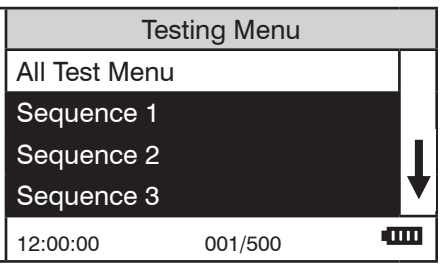
■ TESTING WITH LaMOTTE PRE-PROGRAMMED TESTS

NOTE: Test in the examples may not be included in the COD3 Plus.

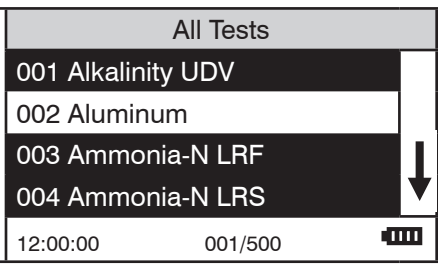
1. Press and briefly hold ⏻ to turn the meter on. The LaMotte logo screen will appear for about 3 seconds and the **Main Menu** will appear.



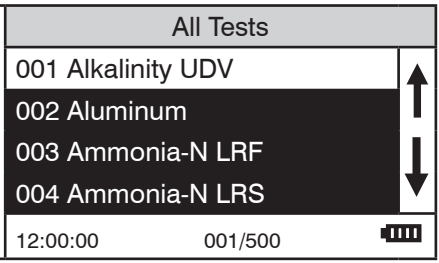
2. Press ENTER to select **Testing Menu**.



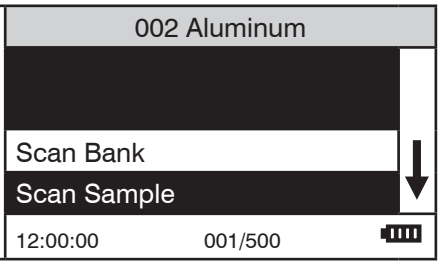
3. Press ENTER to select **All Tests Menu**.



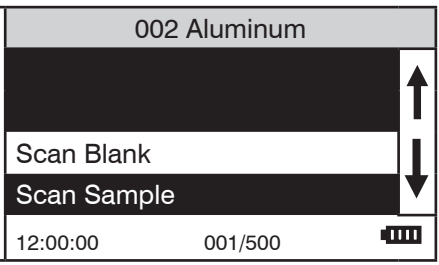
4. Press ^ or v to scroll to the desired test.



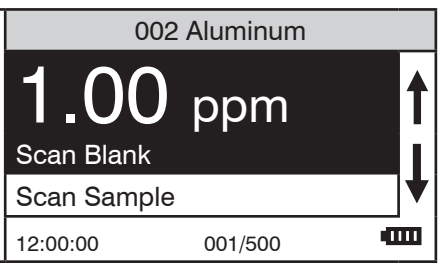
5. Press ENTER to select the test.



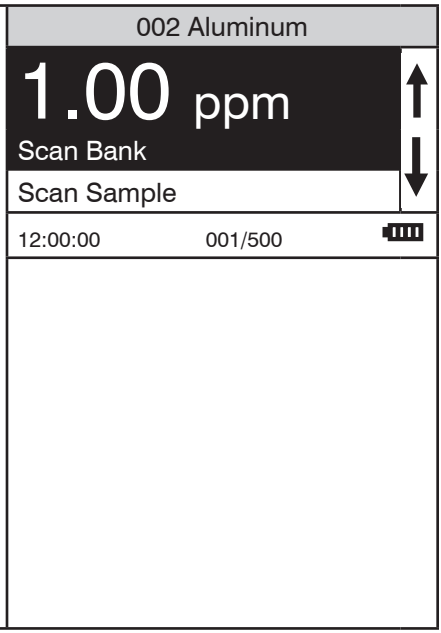
6. Insert the blank into the chamber. Close the lid.Press ENTER to scan the blank. The screen wil display **Blank Done** for about 1 second and then return to the **Test Menu**.



7. Insert the reacted sample into the chamber. Close the lid. Press ENTER to scan the sample. The screen will display **READING** for about 1 second. The result will appear on the screen.



8. To repeat the test, press ENTER to scan the sample again. The last blank scaned is used by the colorimeter for repeated scans. A different blank can be used by pressing ^ or v to scroll to Scan Blank and then scanning another blank. Scroll with ^ or v and make another selection with ENTER. The %T or Absorbance of the last test can be viewed by choosing %T/Abs. Press EXIT to escape to previous menus. NOTE: The menus loop in this screen so either ^ or v will lead to the menu selection needed.



■ CALIBRATING LaMOTTE PRE-PROGRAMMED TESTS

The LaMotte Pre-Programmed Tests have been pre-calibrated. Recalibration of the pre-programmed tests by the user is not possible. However, a procedure to standardize the calibration can be performed to obtain the most accurate readings or to meet regulatory requirements.

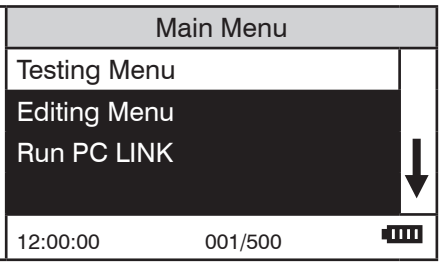
The LaMotte Pre-Programmed tests are standardized with one standard solution. To standardize over the full range of the test, the concentration of the standard should be chosen from the high end of the range. Alternatively, if samples do not cover the full range of the test, a standard should be chosen that is close to the concentration of the samples.

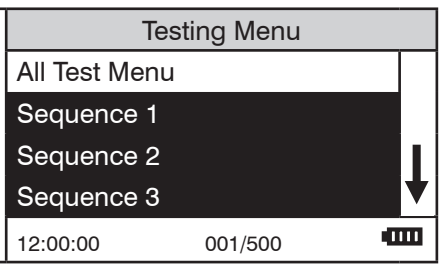
The standardization procedure should be followed as often as required by regulations and laws for compliance monitoring.

In the example below, the Aluminum calibration will be standardized.

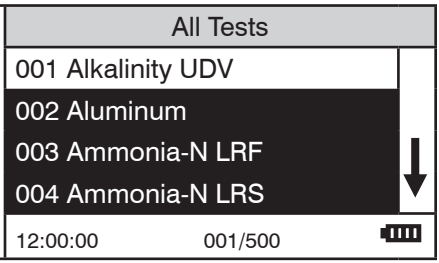
Prepare a standard solution to be tested. In this example, 0.30 ppm aluminum.

NOTE: Aluminum testis used as an example but is not available in the COD3 Plus.

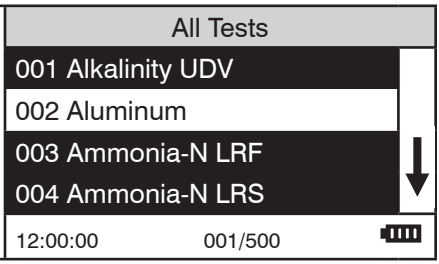
1. Press and briefly hold ⏻ to turn the meter on. The LaMotte logo screen will appear for about 3 seconds and the **Main Menu** will appear.	

2. Press ENTER to select **Testing Menu**.	

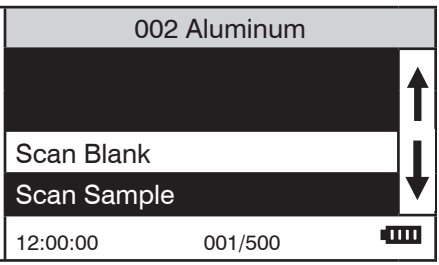
3. Press ENTER to select **All Tests Menu**.



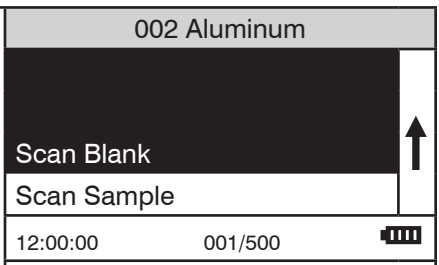
4. Press ▲ or ▼ to scroll to the desired test factor.



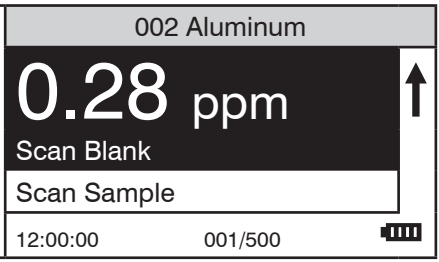
5. Press ENTER to select the test.



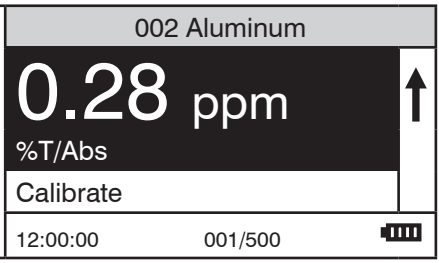
6. Follow the test procedure in the manual to test the prepared standard. Insert the blank into the chamber. Close the lid. Press ENTER to scan the blank. The screen will display **Blank Done** for about 1 second and then return to the **Test Menu**.



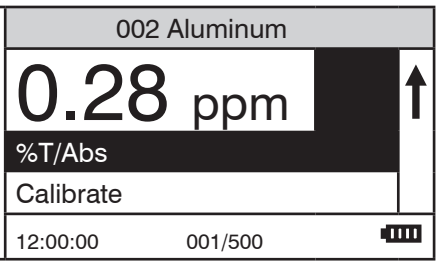
7. Insert the reacted standard solution into the chamber. Close the lid. Press ENTER to scan the sample. The screen will display **Reading** for about 1 second. The result will appear on the screen.



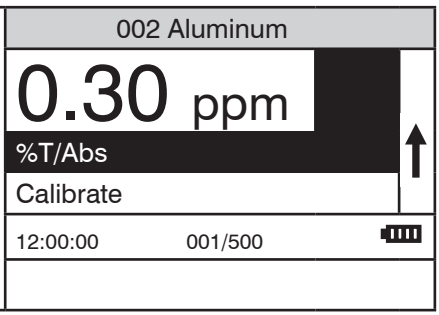
8. The displayed result can now be standardized. Press ^ or v to scroll to calibrate.



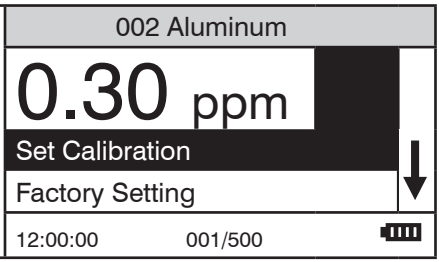
9. Press ENTER to select **Calibrate**. A reverse font (light background with dark characters) will appear to indicate that the reading can be adjusted.



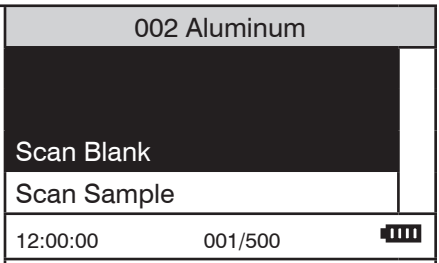
10. Press ^ or v to scroll to the concentration of the prepared standard, 0.30 in this example.
NOTE: A maximum adjustment of 10% is possible. If an adjustment of over 10% is attempted, Overrange will be displayed.



11. Press ENTER to select **Calibrate**. Two menu choices will be offered, set calibration and factory setting.

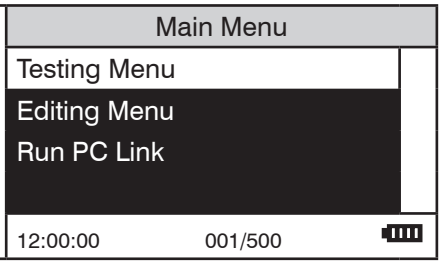


12. Press ENTER to select **Set Calibration** and save the calibration. Or press ▼ to scroll to **Factory Setting**. Press ENTER to select **Factory Setting** to revert to the factory calibration. The screen will display **Storing...** for about 1 second and the test menu will appear. The calibration has now been standardized and the meter can be used for testing. The standardization can be removed by repeating the calibration and selecting **Factory Setting**.

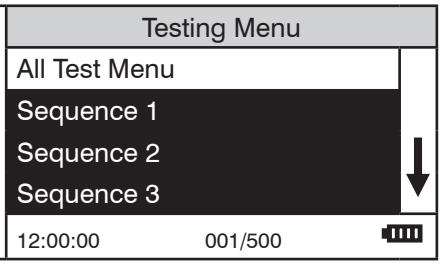


■ MEASURING IN THE ABSORBANCE MODE

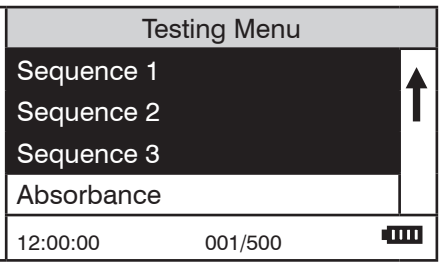
1. Press and briefly hold ⏻ to turn the meter on. The LaMotte logo screen will appear for about 3 seconds and the **Main Menu** will appear.



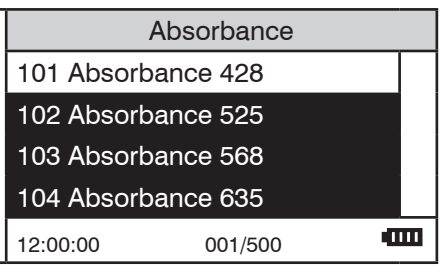
2. Press ENTER to select **Testing Menu**.



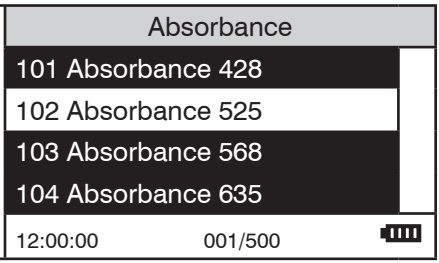
3. Press ^ or v to scroll to **Absorbance**.



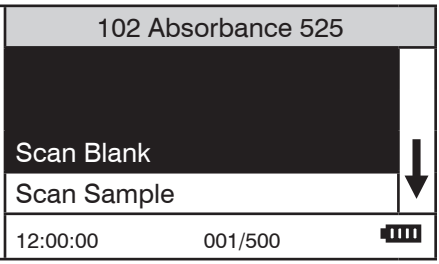
4. Press ENTER to select **Absorbance**.



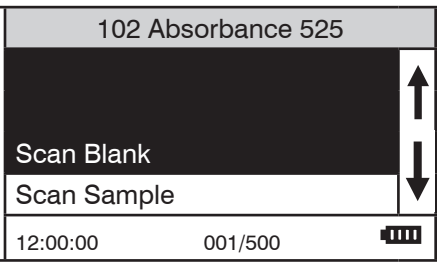
5. Press ^ or v to scroll to desired wavelength.



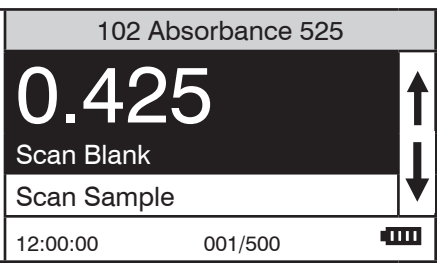
6. Press ENTER to select the wavelength.



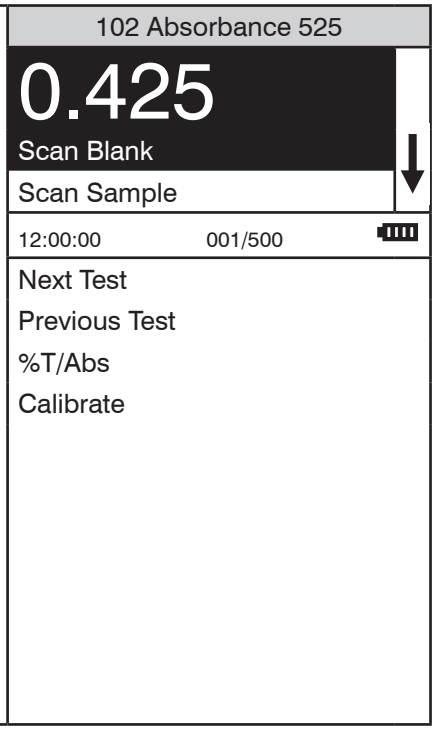
7. Insert the blank. Close the lid. Press ENTER to scan the blank. The screen wil display **Blank Done** for about 1 second and return to the Absorbance menu.



8. Insert the reacted sample. Press ENTER to scan the sample. The screen will display **Reading** for about 1 second. The result will appear on the screen.



9. To repeat the test, press ENTER to scan the sample again. The last blank scanned is used by the colorimeter for repeated scans. A different blank can be used by pressing ^ or v to scroll to **Scan Blank** and then scanning another blank. Scroll with ^ or v and make another selection with ENTER.The %T or Absorbance of the last test can be viewed by choosing %T/Abs. Press EXIT to escape to previous menus.
NOTE: The menus loop in this screen so either ^ or v will lead to the menu selection needed.
NOTE: The calibrate function does not work in the Absorbance mode.



EDITING MENU

The Editing Menu allows the user to edit sequences, edit user tests, set the clock, edit the logging function, access factory setting, set the power saving function, set the backlight time, and select a language.

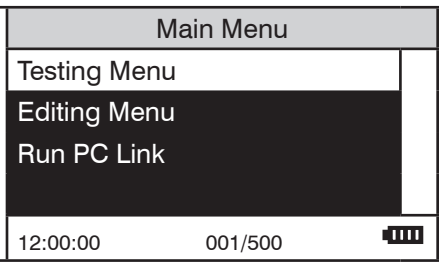
The default factory settings are:

Date Format	MM-DD-YYYY
Logging	Enabled
Power Save	5 minutes
Backlight	10 seconds
Language	English

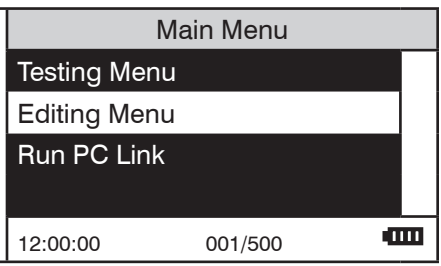
■ EDITING A SEQUENCE

The Edit Sequence menu allows three alterable test sequences (Sequence 1, Sequence 2, Sequence 3) to be edited.

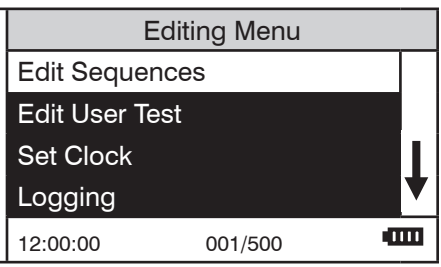
1. Press and briefly hold ⏻ to turn the meter on. The LaMotte logo screen will appear for about 3 seconds and the **Main Menu** will appear.

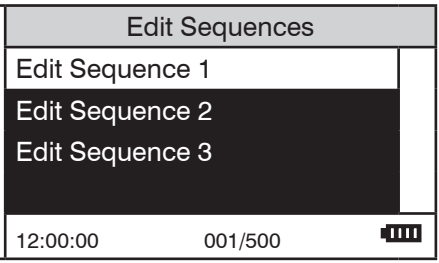
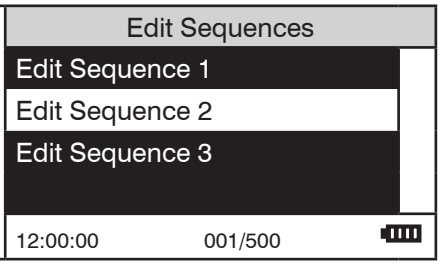
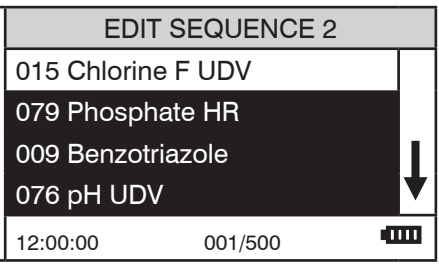


2. Press ▲ or ▼ to scroll to the **Editing Menu.**



3. Press ENTER to select **Editing Menu**.



4. Press ENTER to select **Edit Sequences**.	
5. Press ^ or v to scroll to the desired sequence.	
6. Press ENTER to select the sequence to be edited.	

■ ADDING OR DELETING A TEST

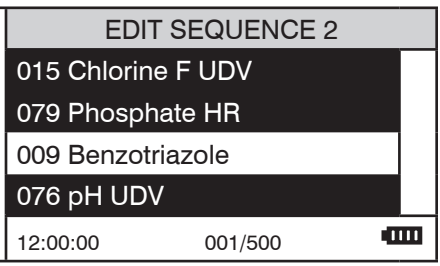
There are three ways to alter a sequence: Insert Before, Insert After, and Delete. Insert Before adds a new test to the sequence before the selected test. Insert After adds a new test to the sequence after the selected test. Delete is used to remove an existing test from a sequence.

NOTE: Test in the examples may not be included in the COD3 Plus.

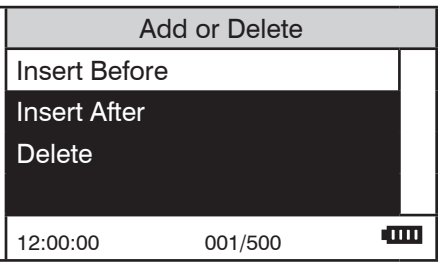
ADDING A TEST

Below is a step-by-step example of how to add a test to SEQUENCE 2 starting from the EDIT SEQUENCE 2 menu.

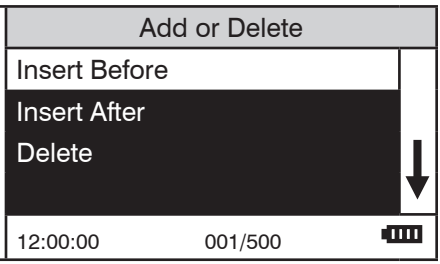
1. To add a test before or after an existing test, press ^ or v to scroll to the existing test.



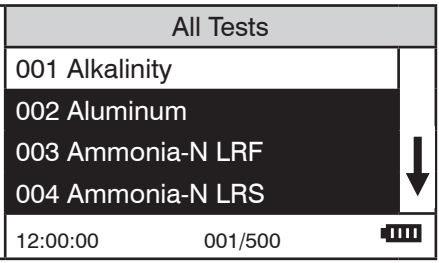
2. Press ENTER to select the existing test.



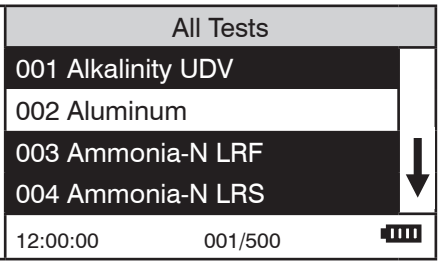
3. Press ^ or v to scroll to **Insert Before** or **Insert After**.



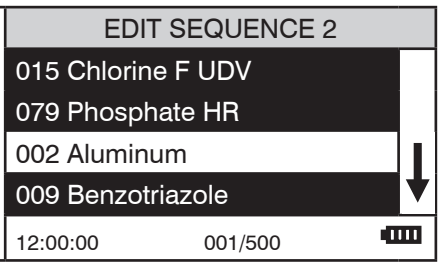
4. Press ENTER to select the option, **Insert Before**, in this example. The **All Test Menu** will appear.



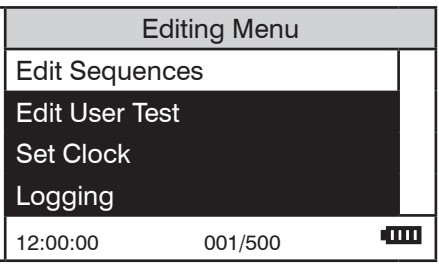
5. Press ^ or v to scroll to the test that will be added to the sequence. In this example, Aluminum.



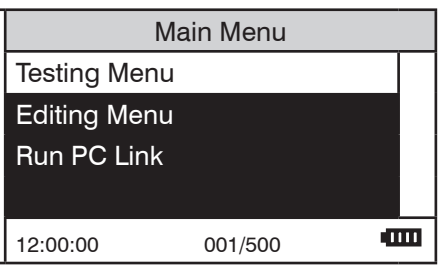
6. Press ENTER to select the test. The sequence will appear in the Edit Sequence menu and the new test will be added to the sequence. All changes in the sequence will be automatically saved.



7. Press EXIT to exit the **Edit Sequence** menu and return to the **Editing Menu**.



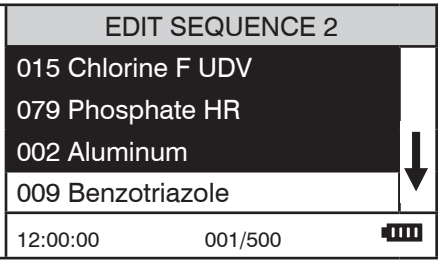
8. Press ENTER to select **Edit Sequences** to continue editing the sequences or press EXIT to return to the **Main Menu**.



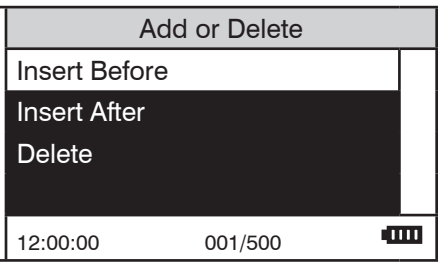
DELETING A TEST

Below is a step-by-step example of how to delete a test in SEQUENCE 2 starting from the EDIT SEQUENCE 2 menu.

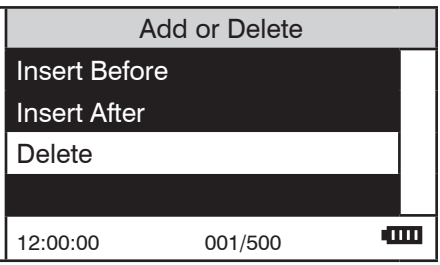
1. To delete a test, press ^ or v to scroll to the test in the sequence.



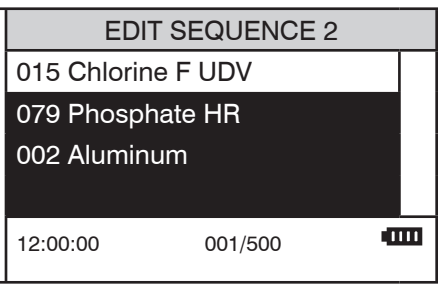
2. Press ENTER to select the test.

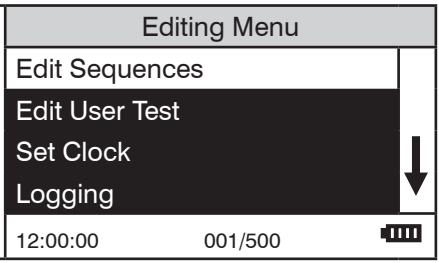


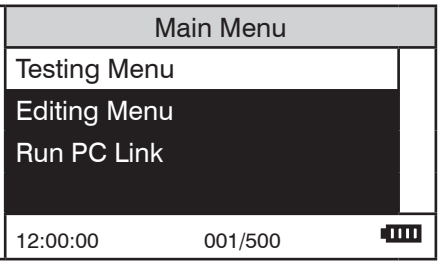
3. Press ^ or v to scroll to **Delete**.



4. Press ENTER to select **Delete**. The sequence will appear in the **EDIT SEQUENCE** menu and the selected test will have been deleted. All changes to the sequence will automatically have been saved.



5. Press EXIT to exit the **Edit Sequence** menu and return to the **Editing Menu**.	

6. Press ENTER to select **Edit Sequences** to continue editing the sequences or press EXIT to return to the **Main Menu**.	

■ EDIT USER TESTS

If a test other than the LaMotte programmed tests is performed regularly, a calibration for it may be entered in one of the 25 User Tests. These tests are originally named “User Test 1 - 25”. It will be possible to rename the test, select a wavelength, enter a new calibration, select the number of decimal places used to display the results, and select the units. A User Test may be added for a reagent system for which no precalibrated test exists. A calibration of a LaMotte reagent system may also be entered. The calibration of a User Test can be changed at any time.

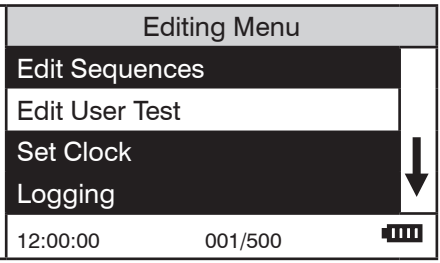
The User Tests have the ability to handle 2 data points. The colorimeter will determine the absorbance of the standards and calculate a response that will be stored to determine the concentration of future samples of unknown concentration. These standards should cover all the concentrations for the range of the test being performed and be scanned beginning with the low concentration and finishing with the high concentration (for more information about this, see CALIBRATION CURVES, page 12). Prepare these standards prior to entering a new calibration.

NOTE: A calibration procedure must be performed before using any of the User Tests.

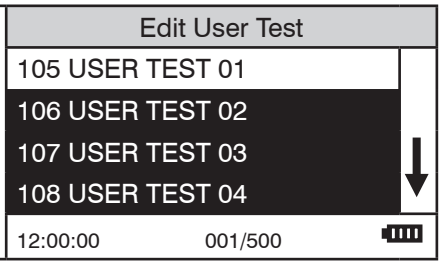
The User Tests can be placed in any of the alterable sequences using Edit Sequences.

1. Press and briefly hold ⏻ to turn the meter on. The LaMotte logo screen will appear for about 3 seconds and the **Main Menu** will appear.	Main Menu Testing Menu Editing Menu Run PC Link 12:00:00 001/500
2. Press ^ or v to scroll to the **Editing Menu.**	Main Menu Testing Menu Editing Menu Run PC Link 12:00:00 001/500

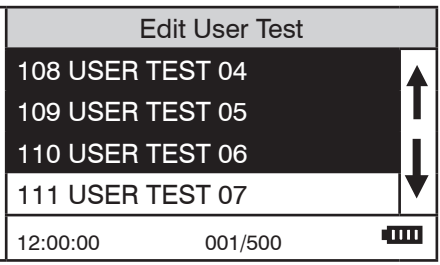
3. Press ENTER to select **Editing Menu**. Press ▼ to scroll to **Edit User Test**.



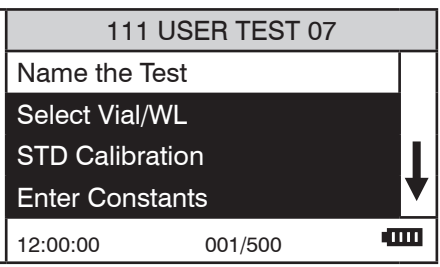
4. Press ENTER to select **Edit User Test**.



5. Press ▲ or ▼ to scroll to the desired user test.



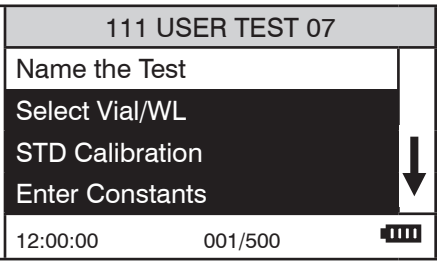
6. Press ENTER to select the **User Test**.



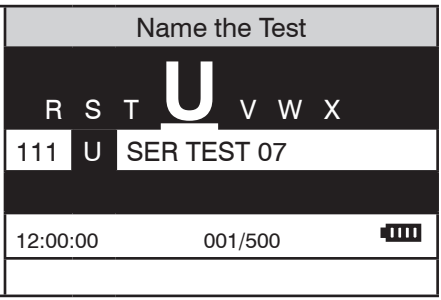
■ NAMING THE TEST

A User Test can be up to 16 characters long. The menu choices for each character are 26 upper case letters A to Z, 26 lower case letters a to z, ten numerals 0 to 9, a space, a dash (-) and a decimal point (.). The existing name is displayed on the bottom line of the display. The character which is to be edited will blink and that character is also displayed in the center of the display. The character can be changed by using ^ or v to scroll to other characters. Use ENTER to select a character. The edited name is saved at any time by pressing EXIT or by pressing ENTER after selecting the sixteenth character.

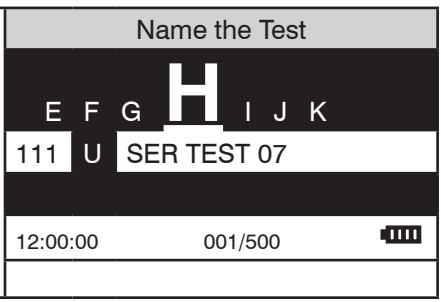
1. From the User Test menu, press v to scroll to **Name the Test**.



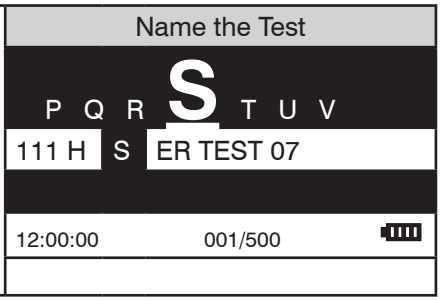
2. Press ENTER to select **Name the Test**. A reverse font (dark background with a light character) will appear to indicate the character that will be adjusted. The same character will also appear in the center of the display.



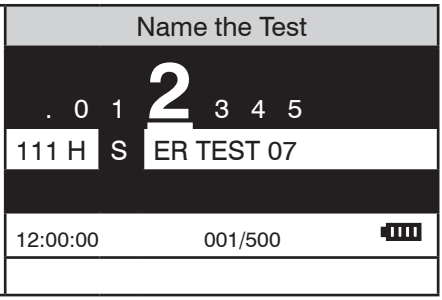
3. Press ^ or v to scroll to the desired character. In this example, the test name will be H2O.



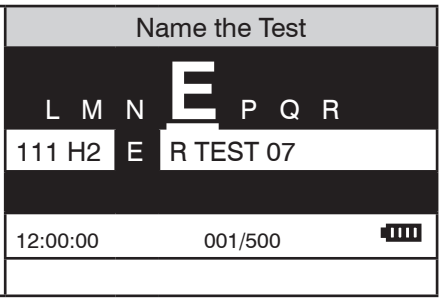
4. Press ENTER to save the character and move to the next character.



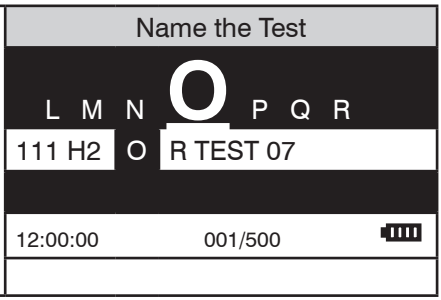
5. Press ^ or v to scroll to the desired character.

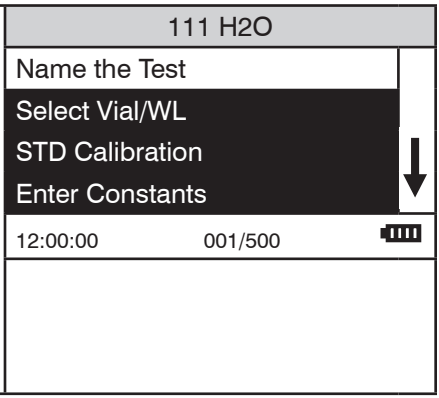


6. Press ENTER to save the character and move to the next character.



7. Press ^ or v to scroll to the desired character.

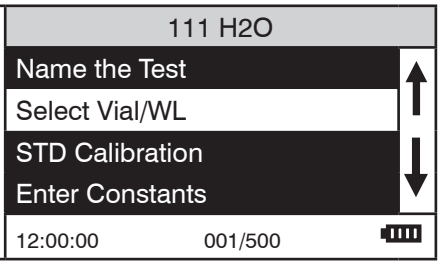


8. Press ENTER to save the character. Repeat the procedure until the test name is complete. To remove a character, change the character to a space (located after the letter z). Press EXIT to save the name. The sreen will display **Storing...** and the test name for about 1 second and the meter will return to the **Edit Test** menu.	

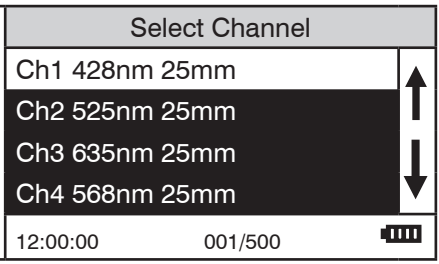
■ SELECTING THE VIAL AND WAVELENGTH

The COD3 Plus Colorimeter accepts three different vials (the 25 mm 0290 tube, UDVs and COD tubes) at 2 different wavelengths (428 and 635 nm). The colorimeter uses different settings for each of the twelve combinations of vial and wavelength. These twelve settings are called channels. Choose the channel with the correct wavelength and vial for the test.

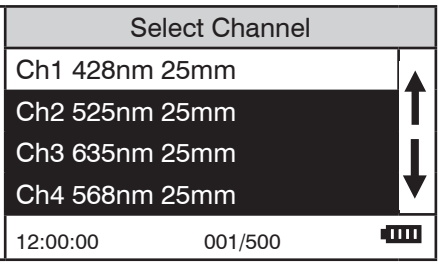
1. From the **User Test** menu, press ^ or v to scroll to Select Vial/WL.



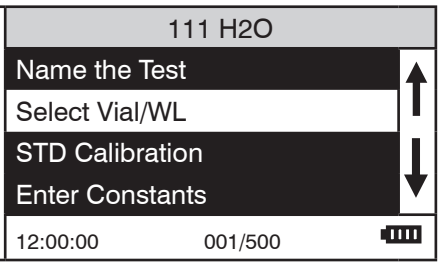
2. Press ENTER to select **Select Vial/WL**.



3. Press ^ or v to select the channel with the desired wavelength and vial size combination.



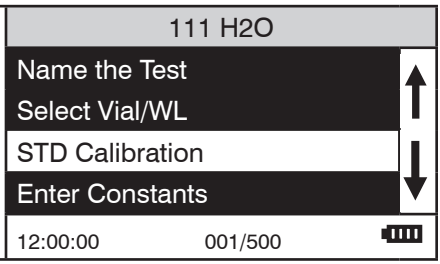
4. Press ENTER to select the channel. The screen will display **Storing...** for about 1 second and the meter will return to the **Edit Test** menu.



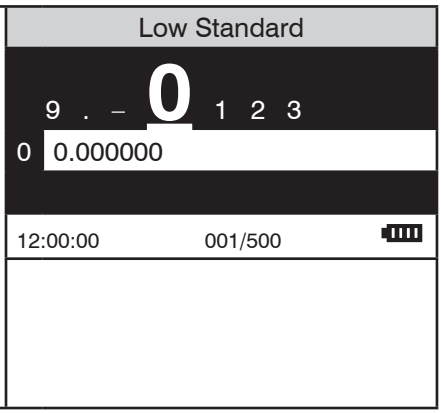
■ ENTERING A TWO POINT CALIBRATION

The COD3 Plus Colorimeter can scan two reacted standards and create a calibration curve. To prepare a calibration curve with multiple data points see Entering a Multiple Calibration Curve (pg. 55).

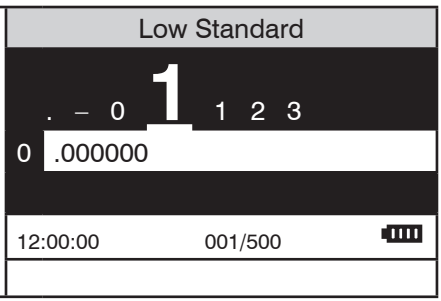
1. From the **User Test** menu, press ▲ or ▼ to scroll to **STD** (Standard) **Calibration**.



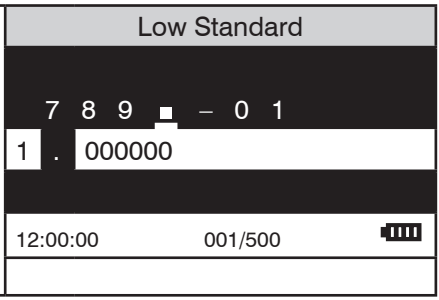
2. Press ENTER to select **STD Calibration**. The screen will display Low Standard for about 1 second and then display the Low Standard screen. A reverse font (dark background with a light character) will appear to indicate the character that will be adjusted. The same character will also appear in the center of the display.



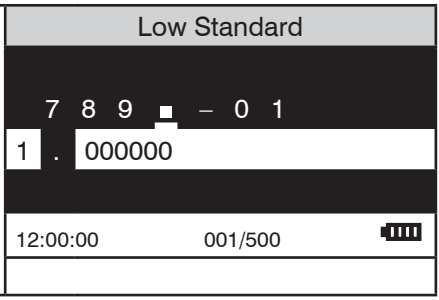
3. Press ▲ or ▼ to scroll to the first character of the low concentration. In this example, 1.00 ppm.



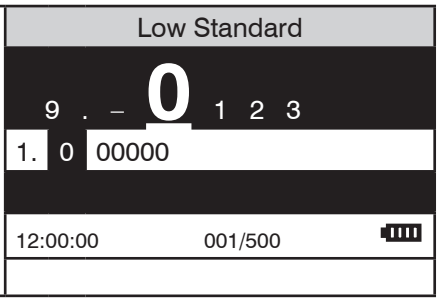
4. Press ENTER to save the character and move to the next character.



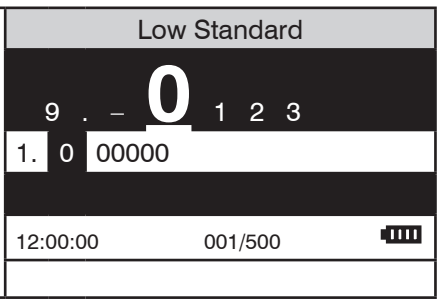
5. Press ^ or v to scroll to the desired character.



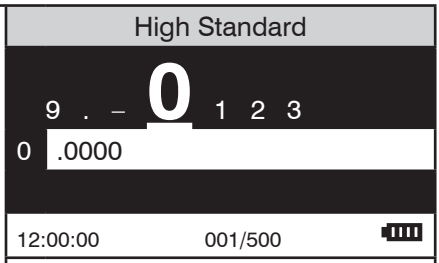
6. Press ENTER to save the character and move to the next character.



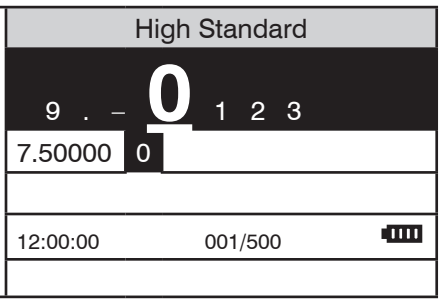
7. Press ^ or v to scroll to the desired character.



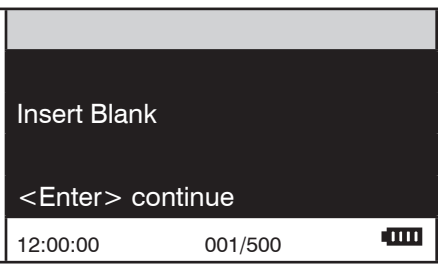
8. Press ENTER to save the character. Repeat the procedure until the low concentration value is complete. After the final character is complete the meter will save the low concentration value. The screen will display **High Standard** for about 1 minute and the meter will display the **High Standard** screen. A reverse font (dark background with a light character) will appear to indicate the character that will be adjusted. The same character will appear in the center of the display.



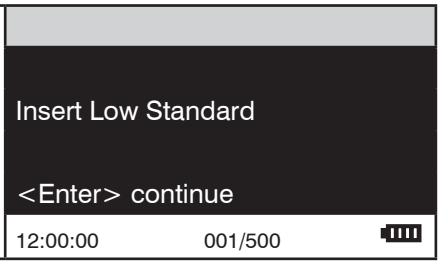
9. Use ^ or v and ENTER to select the characters for the high concentration value. In this example, 7.5 ppm.



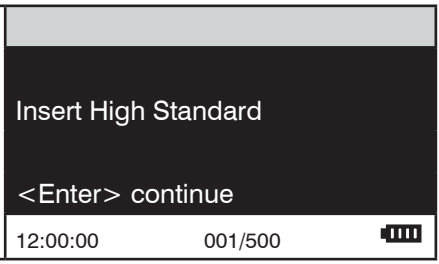
10. After the final character is entered the meter will save the high concentration value. The screen will display instructions for completing the calibration procedure.



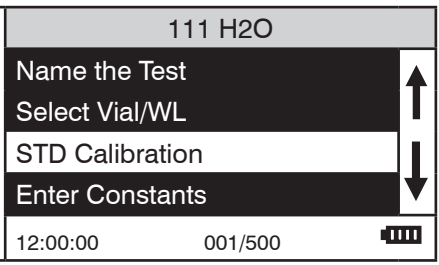
11. Insert the blank. Press ENTER. The screen will display **Blank Done...** for about 1 second and the **Insert Low Standard** screen will appear.



12. Insert the low standard. Press ENTER. The screen will display **Reading...** for about 1 second and the **Insert High Standard** screen will be displayed.



13. Insert the high standard. Press ENTER. The screen will display **Reading...** for about 1 second and the meter will return to the **Edit Test** menu.



■ ENTERING A MULTIPLE POINT CALIBRATION

The COD3 Plus can directly create a 2 point calibration curve. (See Entering a Two Point Calibration on page 51.) To create a multiple point calibration curve, constants obtained from a linear regression of multiple data points can be entered into the COD3 Plus.

1. Scan reactions of multiple concentrations at the appropriate wavelength in the absorbance mode on the COD3 Plus.
2. Plot the concentration (y axis) versus absorbance (x axis) in a program capable of linear regression such as Excel.
3. Enter the constants obtained from the linear regression equation into the COD3 Plus.

   For Example:

   $y = 0.001x^3 - 0.017x^2 + 0.181x - 0.049$

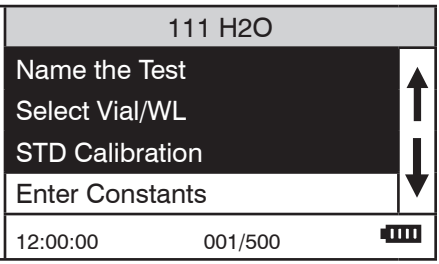
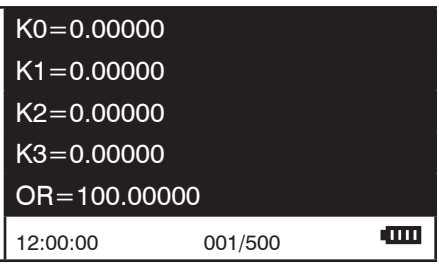
   K0 = – 0.049

   K1 = 0.181

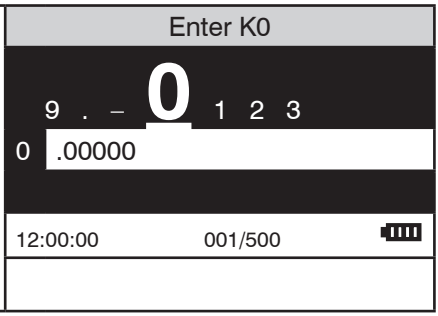
   K2 = – 0.017

   K3 = 0.001

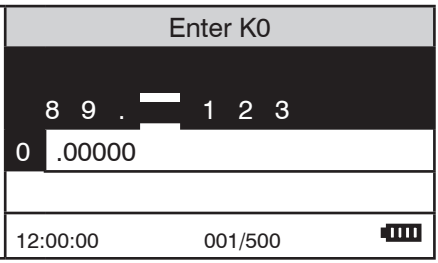
   OR (Over Range) = 10

1. From the User Test menu, press ▲ or ▼ to scroll to **Enter Constants**.	
2. Press ENTER to select **Enter Constants**.	

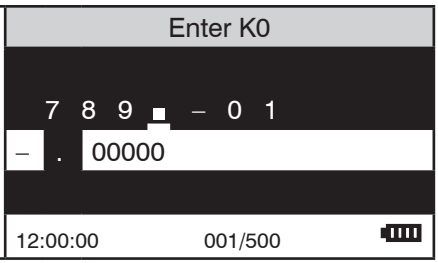
3. Press ENTER to begin entering the values for the constants. A reverse font (dark background with a light character) will appear to indicate the character that will be adjusted. The same character will also appear in the center of the display.



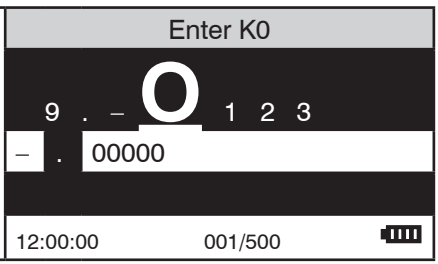
4. Press ^ or v to scroll to the first character of K0. In this example, – 0.049.



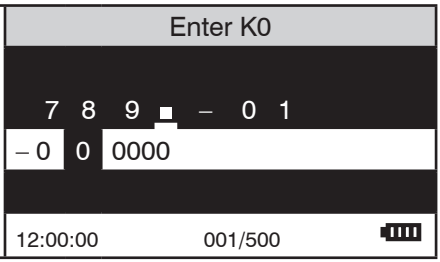
5. Press ENTER to save the character and move to the next character.



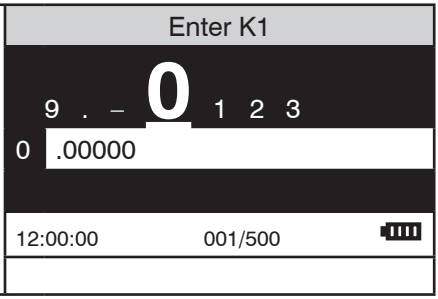
6. Press ^ or v to scroll to the next character.



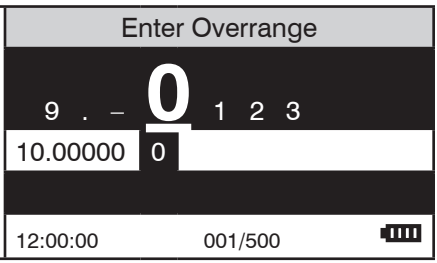
7. Press ENTER to save the character and move to the next character. Press ^ or v to scroll to the next character.



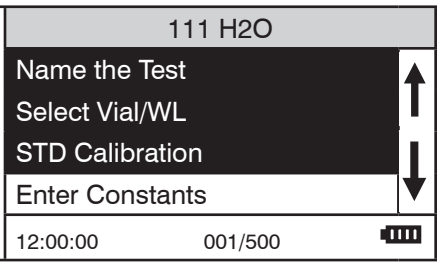
8. Press ENTER to save the character. Repeat the procedure until the K0 value is complete. After the final character is complete the meter will save the K0 value and the meter will display K1 screen.



9. Use ^ , v and ENTER to select the characters for the remaining values: K1, K2, K3, and over range. In this example, 10 ppm.



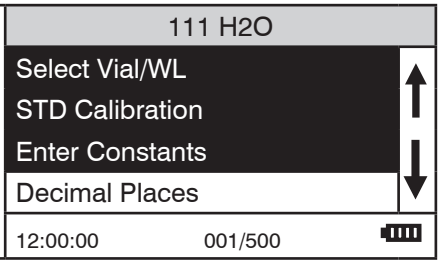
10. After the final character is entered the meter will save the constants. The screen will display **Storing...** and return to the **Edit Test** menu.



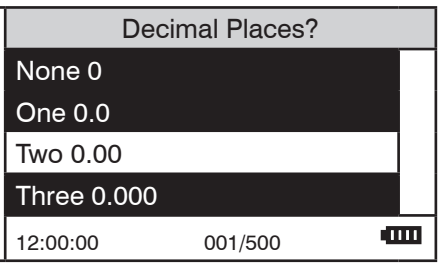
■ SELECTING THE NUMERICAL FORMAT OF THE RESULT

To input tests with very different ranges, the number of decimal places displayed for a result can be selected. A test which ranges from 20 to 1000 ppm should not be displayed with three decimal places. A test with a range from 0.010 to 0.500 needs three decimal places (the microprocessor will always calculate the concentration to many more significant figures than will be displayed). The choice of 0, 1, 2, or 3 decimal places are available.

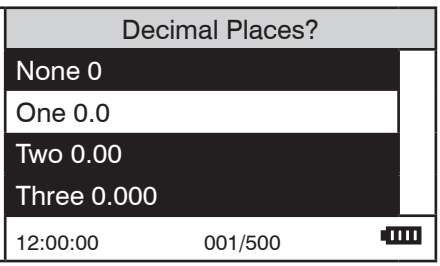
1. From the User Test menu, press ^ or v to scroll to **Decimal Places**.



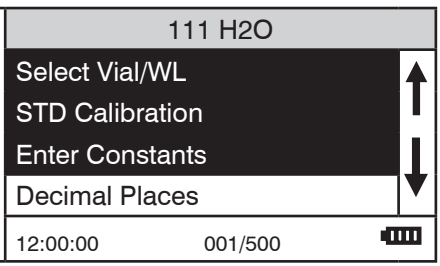
2. Press ENTER to select **Decimal Places**.



3. Press ^ or v to scroll to the desired number of decimal places.



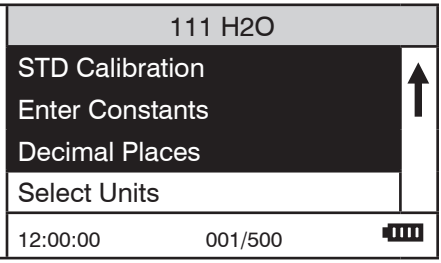
4. Press ENTER to select the decimal places. The screen wil display **Storing...** for about 1 second and the meter will return to the **Edit Test** menu.



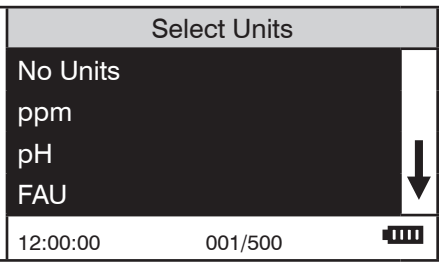
■ SELECTING THE UNITS OF CONCENTRATION

The COD3 Plus Colorimeter has seven options for units of concentration. They are No Units, ppm, FAU, pH, ppb, ppt and mgL.

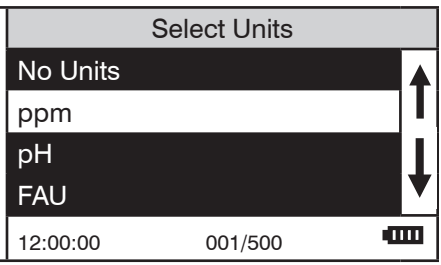
1. From the User Menu, press ^ to scroll to **Select Units**.



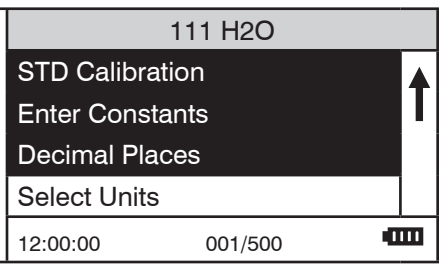
2. Press ENTER to select **Select Units**.



3. Press ^ or v to scroll to the desired units.



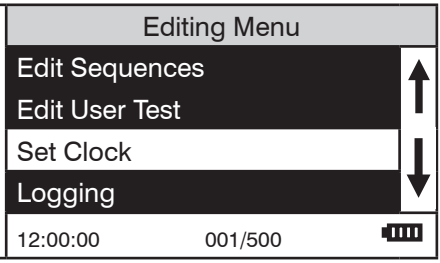
4. Press ENTER to select the units. The screen will display **Storing...** for about 1 second and the meter will return to the **Edit Test** menu.



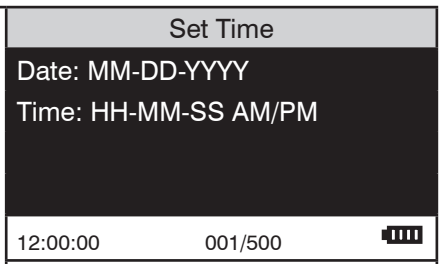
■ SETTING THE CLOCK

Setting the clock allows the correct time and date stamp to be stored with each reading in the data logger.

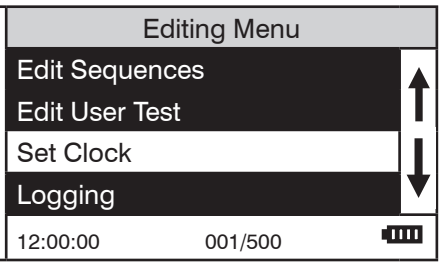
1. From the **Editing Menu**, press ▲ or ▼ to scroll to **Set Clock**.



2. Press ENTER to select **Set Clock**. The date is displayed as month-day-year. The time is displayed as hours:minutes:seconds AM/PM. Press ▲ or ▼ to scroll to the appropriate character. Press ENTER to select the character. The curser will move to the next character. Set all characters in the same manner. The character menu is a scrolling menu.



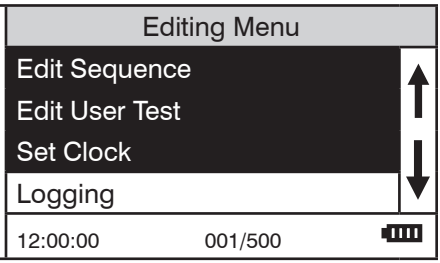
3. Press ENTER to select the final character. The time and date will be saved and the meter will return to the **Edit Test** menu.



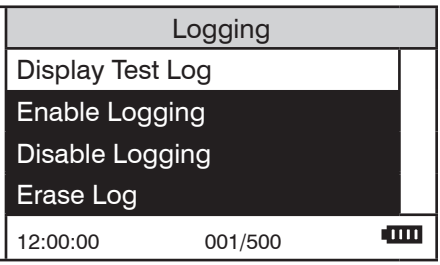
■ LOGGING DATA

The default setting for the data logger is enabled. The meter will log the last 500 data points. The counter in the center bottom of the display will show how many data points have been logged. The display will show 500+ when the data logger has exceeded 500 points and the data points are being overwritten.

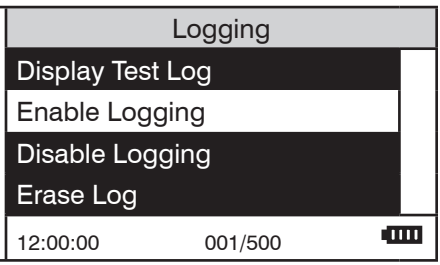
1. From the **Editing Menu**, press ^ or v to scroll to **Logging**.



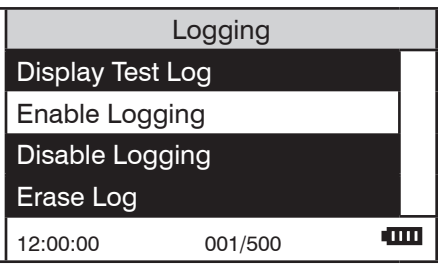
2. Press ENTER to select **Logging**.

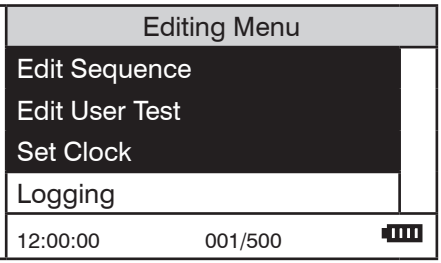


3. Press ^ or v to scroll to desired function.



4. Press ENTER. The screen will display **Storing...** for about 1 second and return to the **Logging** menu.



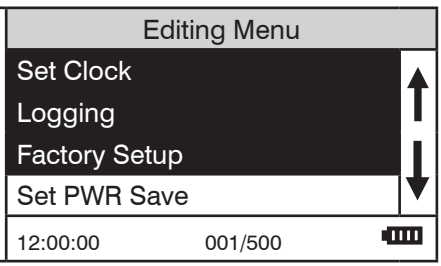
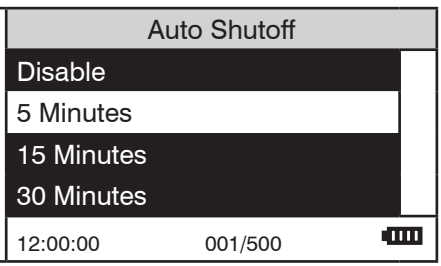
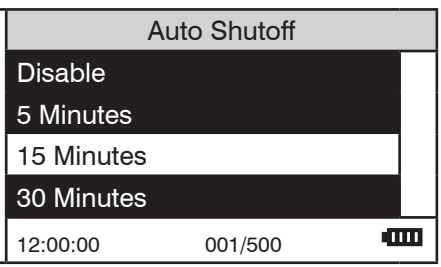
5. Press EXIT to return to the **Editing Menu**.	

■ FACTORY SETUP

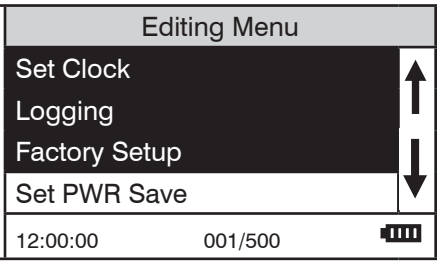
The Factory Setup menu is used in manufacturing of the COD3 Plus Colorimeter. This menu is not for use by the operator in the field.

■ SETTING POWER SAVE

The power saving Auto Shutoff feature will turn the meter off when a button has not been pushed for a set amount of time. The default setting is disabled. To change the setting:

1. From the **Editing Menu**, press ^ or v to scroll to **Set PWR Save**.	
2. Press ENTER to select **Set PWR Save**.	
3. Press ^ or v to scroll to desired function.	

4. Press ENTER. The screen will display **Storing...** for about 1 second and the meter will return to the **Editing Menu**.

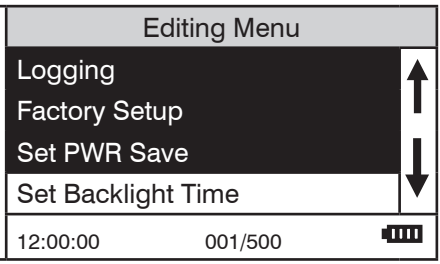


■ SETTING THE BACKLIGHT TIME

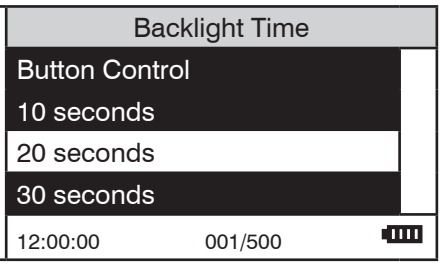
The backlight illuminates the display for enhanced viewing. The default setting is 10 seconds. If Button Control is chosen the backlight button on the key pad will act as an on/off switch and the backlight will remain on or off when the meter is being used. When one of the other settings – 10, 20 or 30 seconds – is chosen, the display will be illuminated for the specified amount of time after any button is pressed.

NOTE: The backlight feature uses a significant amount of power. The longer the backlight is on, the more frequently the battery will have to be charged if the USB/Wall Adapter is not being used.

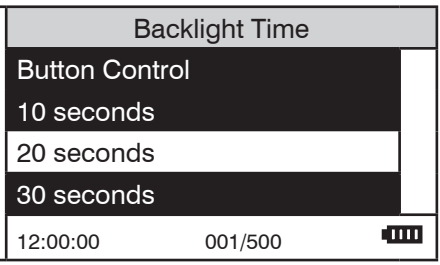
1. From the **Editing Menu**, press ▲ or ▼ to scroll to **Backlight Time**.



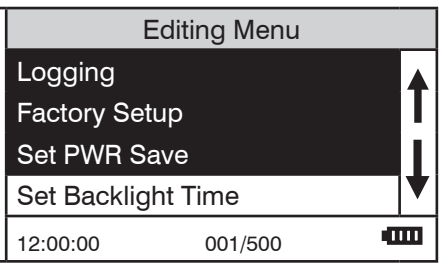
2. Press ENTER to select **Set Backlight Time**.



3. Press ▲ or ▼ to scroll to desired option.



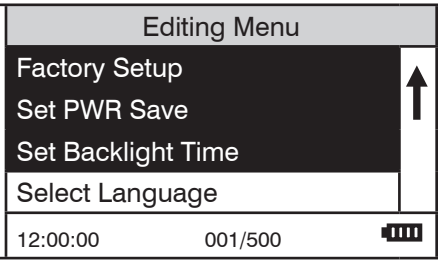
4. Press ENTER. The screen will display **Storing...** for about 1 second and the meter will return to the **Editing Menu**.



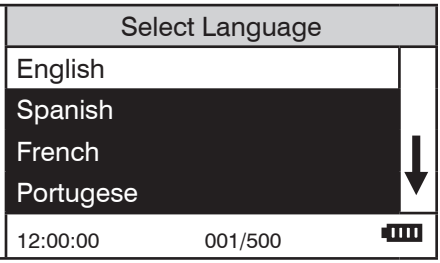
■ SELECTING A LANGUAGE

There are seven languages available in the COD3 Plus: English, Spanish, French, Portuguese, Italian, Chinese, and Japanese.

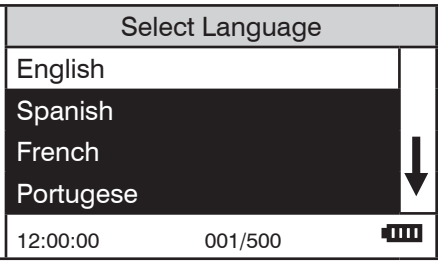
1. From the **Editing Menu**, press ▲ or ▼ to scroll to **Select Language**.



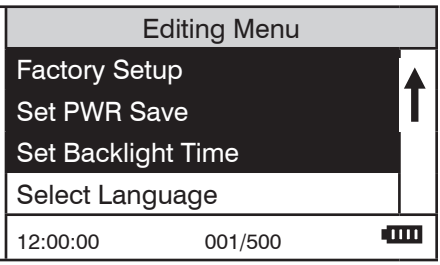
2. Press ENTER to select **Select Language**.



3. Press ▲ or ▼ to scroll to desired language.



4. Press ENTER. The screen will display **Storing...** for about 1 second and the meter will return to the **Editing Menu**.



NOTE: If meter unintentionally switches to another language, use the procedure above to reset the meter to the desired language. For example, to reset the meter to English:

1. Turn meter on.
2. Press ▼ one time. Press ENTER.
3. Press ▼ seven times. Press ENTER.
4. Press ENTER.

COMPUTER CONNECTION

■ PC LINK

The COD3 Plus may be interfaced with any Windows-based computer by using the LaMotte SMARTLink 3 Program and USB Cable. The program will store test information and results in a database. To transfer data from the meter to a computer, plug the smaller end of the USB cable (USB mini B connector) into the meter and the larger end of the USB cable (USB Type A connector) into a USB port on a computer. The COD3 Plus will send the following data: test name, wavelength, concentration, transmittance, absorbance, sample, blank, time of test, and date of test.

■ OUTPUT

USB

■ COMPUTER CONNECTION

USB Type A, USB mini B, Order Cable Code 1720.

■ SMARTLINK3

SmartLink3 records the above data and appends a test ID# which uniquely identifies the test in the database, the serial number of the meter, and a site ID# which can be used to associate the test record with a site or customer via the SmartLink3 program. It also stores a “test number” which is useful for the COD3 Plus.

BATTERY

■ BATTERY/AC OPERATION

The COD3 Plus may be operated on battery power, using a USB wall adapter or USB computer connection. If using the meter as a bench top unit, use the wall adapter if possible to extend the battery life. The meter will remain on when the USB adapter is used.

To charge the battery with the wall adapter, plug the smaller end of the USB cable (USB mini B connector) into the meter and the larger end of the USB cable (USB Type A connector) into the wall adapter. Plug the wall adapter into an AC outlet. Reinsert the USB port plug after charging.

To charge the battery from a computer, plug the smaller end of the USB cable (USB mini B connector) into the meter and the larger end of the USB cable (USB Type A connector) into a USB port on a computer.

The battery icon will show no bars and flash when the unit first turns on. Then the indicator will indicate the battery status by showing 0, 1, 2, 3 or 4 bars.

It will take 5 hours to fully charge a low battery. The battery icon will flash when the battery is charging. The battery icon will show four bars and stop flashing when it is fully charged. The charging circuit will automatically switch to a float charge when the battery is fully charged. The charger may remain connected. Some computers will NOT supply power to their USB ports during standby operation. The wall adapter will charge the unit continuously.

The battery icon will show no bars and continuously flash if the battery is getting low but the unit will still operate normally. A “Low Battery” message on the status bar of the display will replace the time when the battery voltage is too low for proper operation and accuracy may be degraded. A “Shutdown Low Batt” message on the display will appear for a few seconds before the power is switched off when the battery is too low to operate the unit.

To extend the battery life:

- Shut down the unit with the power switch when not taking measurements or use the power save option to have the unit automatically turn off after 5 minutes.
- Store the unit in a cool dry place.
- Fully charge the battery before storing the unit for extended periods of time.
- Limit backlight use. The unit consumes 3X normal power with the backlight on. Set the backlight time option to 10 seconds, or select “Button Control” and keep the backlight off.

Battery replacement: The lithium ion battery used in this unit should last for many years with normal use. When it no longer powers the unit long enough to meet testing requirements it will need to be replaced. Lithium ion batteries that are properly charged and stored do not usually lose all capacity; they just have

less capacity after hundreds of charge cycles. This unit uses a custom battery assembly that is only available from LaMotte Company. Battery replacement must be performed at a LaMotte authorized repair facility. The water resistant housing of this meter should not be opened by the user. Contact LaMotte Company by phone (1-800-344-3100) or email (tech@lamotte.com) for a return authorization number.

MAINTENANCE

■ CLEANING

Clean the exterior housing with a damp, lint-free cloth. Do not allow water to enter the light chamber or any other parts of the meter. To clean the light chamber and optics area, point a can of compressed air into the light chamber and blow the pressurized air into the light chamber. Use a cotton swab dampened with Windex® window cleaner to gently swab the interior of the chamber. Do not use alcohol; it will leave a thin residue over the optics when dry.

■ REPAIRS

Should it be necessary to return the meter for repair or servicing, pack the meter carefully in a suitable container with adequate packing material. A return authorization number must be obtained from LaMotte Company by calling 800-344-3100 (US only) or 410-778-3100, faxing 410-778-6394, or emailing tech@lamotte.com. Often a problem can be resolved over the phone or by email. If a return of the meter is necessary, attach a letter with the return authorization number, meter serial number, a brief description of problem and contact information including phone and FAX numbers to the shipping carton. This information will enable the service department to make the required repairs more efficiently.

■ METER DISPOSAL

Waste Electrical and Electronic Equipment (WEEE)

Natural resources were used in the production of this equipment. This equipment may contain materials that are hazardous to health and the environment. To avoid harm to the environment and natural resources, the use of appropriate take-back systems is recommended. The crossed out wheeled bin symbol on the meter encourages the use of these systems when disposing of this equipment.

Take-back systems will allow the materials to be reused or recycled in a way that will not harm the environment. For more information on approved collection, reuse, and recycling systems contact local or regional waste administration or recycling services.

TROUBLESHOOTING

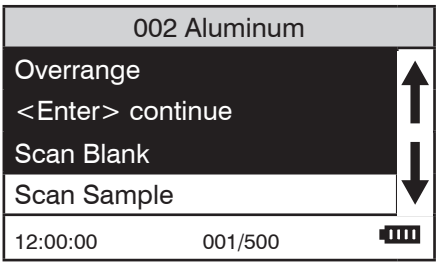
■ ERROR MESSAGES

OVER RANGE

If the message OVERRANGE is displayed when scanning a sample, the sample may be over range or under range. If the sample is over range the sample should be diluted and tested again (see Sample Dilution Techniques and Volumetric Measurements, page 19).

If overrange is displayed, press ENTER to continue testing on diluted samples.

Note: After pressing ENTER, the overrange cncentration will be displayed. This concentration is an **approximation only**.



CALIBRATION

As with all pre-calibrated meters, it is highly recommended, even if not required by regulations, that the user periodically verify the performance of the meter by running standards with a predetermined concentration. Results outside of specification are an indication that the meter needs to be adjusted. This can be done following the user calibration described on page 28. If the user calibration fails to properly adjust the meter then the meter should be returned to LaMotte Company for recalibration. (See page 65).

STRAY LIGHT

The COD3 Plus Colorimeter should have no problems with stray light. Make sure that the sample compartment lid is always fully closed, except when testing COD with the adapter.

■ TROUBLESHOOTING GUIDE

PROBLEM	*REASON*	*SOLUTION*
Flashing	Low battery. Readings are reliable.	Charge battery or use USB wall/computer adapter.
“Low Battery”	Battery voltage is very low. Readings are not reliable.	Charge battery or use USB wall/computer adapter.
“Shut Down Low Batt” Shut Down	Battery is too low to operate the unit.	Charge battery or use USB wall/computer adapter.
“Overrange”	Sample is outside of acceptable range.	Dilute sample and test again.
Unusually large negative or positive readings when performing calibration	Incorrect standards used to calibrate meter.	Use fresh 0.0 standard in clean tube. Reset meter to factory default settings. Recalibrate meter.

1925-TEST

Version 1.0

3.13.11

LaMotte

WARNING! This set contains chemicals that may be harmful if misused. Read cautions on individual containers carefully. Not to be used by children except under adult supervision

COD3 Plus COLORIMETER REAGENT SYSTEMS

■ COD3 Plus REAGENT SYSTEMS LIST

LaMotte Company continuously updates the list of pre-programmed tests as the calibrations become available. Pre-programmed calibrations can be added to the COD3 Plus Colorimeter in the field. A Windows-based computer running a Windows Operating System and an 8 pin mini-DIN/9 pin F D-submin serial cable (order Code 1771) are required.

Test Factor (Test #)	Range (ppm)	MDL	Test Method (# of Reagents)	# of Tests
COD-Low Range (001)	0–150	7.5	Digestion (1)	25
COD-Standard Range (002)	0-1500	40	Digestion (1)	25
COD-High Range (003)	0–15000	400	Digestion (1)	25
Ammonia Nitrogen-Low Range, Fresh Water (005)	0.00–1.00	0.05	Salicylate (3)	25
Ammonia Nitrogen-Low Range, Salt Water (004)	0.00–1.00	0.10	Salicylate (3)	25
Ammonia Nitrogen-High Range (006)	0.00–4.00	0.05	Nesslerization (2)	50
Boron (007)	0.00-0.80	0.05	Azomethine-H (2)	50
Cobalt (008)	0.00–2.00	0.04	PAN (3)	50
Color (009)	0–1000	20	Platinum Cobalt (0)	–
Copper-Cuprizone (010)	0.00–2.50	0.03	Cuprizone (2)	50
Copper-DDC (011)	0.00–7.00	0.10	Diethyldithiocarbamate (1)	50
Cyanuric Acid (012)	5–200	10	Melamine (1)	50
Dissolved Oxygen (013)	0.0–10.0	0.6	Winkler Colorimetric (3)	100
Fluoride (014)	0.00–2.00	0.10	SPADNS (2)	50
Hydrazine (015)	0.00–1.00	0.01	P-dimethyl-aminobenzaldehyde (2)	50
Molybdenum-High Range (016)	0.0–50.0	0.6	Thioglycolate (3)	50
Nickel (017)	0.00–8.00	0.15	Dimethylglyoxime (6)	50
Ozone-Low Range (018)	0.00–0.40	0.02	Indigo Trisulfonate (3)	100
Ozone-High Range (019)	0.00–3.00	0.05	Indigo Trisulfonate (3)	20
Phosphate-Low Range (020)	0.00–3.00	0.05	Ascorbic Acid Reduction (2)	25
Phosphate-High Range (021)	0.0–70.0	0.5	Vanodomolybd-phosphoric Acid (1)	25

Potassium (022)	0.0-10.0	0.8	Tetraphenylboron (2)	100
Silica-Low Range (023)	0.0–4.0	0.05	Heteropoly Blue (4)	50
Silica-High Range (024)	0–75	0.5	Silicomolybdate (3)	50
Sulfate-High Range (025)	0–100	3	Barium Chloride (1)	50
Sulfide-Low Range (026)	0.00–1.50	0.06	Methylene Blue (3)	50
Tannin (027)	0.0–10.0	0.1	Tungsto-molybdophosphoric Acid (2)	50
Turbidity (028)	0.0–30.0 FTU	3	Absorption (0)	–
Zinc-Low Range (029)	0.00–3.00	0.05	Zincon (6)	50

COD – LOW RANGE

MERCURY FREE DIGESTION METHOD • CODE 0072-SC
MERCURY DIGESTION METHOD • CODE 0075-SC

QUANTITY	CONTENTS	CODE
25	*COD Low Range Mercury Free Tubes	*0072-SC
or 25	*COD Low Range Mercury Tubes	*0075-SC

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

COD Low Range Mercury Free Tubes are not USEPA approved.

COD Low Range Mercury Tubes are USEPA approved.

Equipment needed but not supplied:

1	COD Adapter	5-0087
1	COD Reactor, 12 tube, 110V	5-0102
or 1	COD Reactor, 12 tube, 230V	5-0102-EX2
1	Measuring Pipet, 1.0 mL	2-2110
1	Pipet Bulb	2-2164

Chemical Oxygen Demand (COD) is a measure of the amount of organic matter in water which is susceptible to oxidation by chemical oxidants. COD can be empirically related to the Biological Oxygen Demand (BOD) and organic carbon content of a specific source of water. This correlation must be determined experimentally for each source of water.

APPLICATION:	Domestic and industrial wastes.
RANGE:	0–150 mg/L COD
MDL:	7.5 mg/L
METHOD:	Dichromate in the presence of silver salts, at high temperature in a closed system, oxidizes most organic compounds to 95-100% of the theoretical amount. This process is called digestion. As dichromate oxidizes the organic compounds, the amount of yellow color is reduced. The remaining yellow color is measured colorimetrically at the 420 nm and is directly proportional to the COD of the sample.
SAMPLE HANDLING & PRESERVATION:	Collect samples in glass and test as soon as possible. If samples must be stored, preservation is accomplished by the addition of concentrated H2SO4 to adjust the pH below 2. Samples with suspended solids should be homogenized in a blender (100 mL for 30 seconds) and then stirred gently with a magnetic stirrer.
INTERFERENCES:	Volatile organic compounds are not oxidized to the extent that they are in the vapor above the digestion solution. Therefore, they do not contribute to the COD reading. Chloride concentrations above 10% of COD interfere with the mercury free tubes. Chloride above 2000 ppm will interfere with the mercury tubes. Nitrite gives a positive interference of 1.1 ppm O_2 per ppm NO_2–N which is insignificant unless nitrite concentrations are very high. Other reduced inorganic compounds are stoichiometrically oxidized, causing a positive interference. Corrections can be made for these compounds based upon their stoichiometry and concentrations. When scanning samples in 16 mm tubes, such as COD, the sample chamber lid can not be closed. Use the COD adapter to minimize stray light interference. To further reduce stray light interference, do not scan sample in direct sunlight.

PROCEDURE

Use COD/UDV adapter.

1. Homogenize sample if necessary.
2. Preheat COD heater block to 150±2°C.
3. Remove cap from COD tube. Hold tube at a 45° angle. Use a volumetric pipet, to carefully add 2.0 mL sample water allowing the sample to run down the side of the tube.
4. Cap and mix thoroughly.
5. Rinse the outside of the tube with distilled water. Wipe dry with a paper towel.
6. Repeat steps 3 through 5 using 2.0 mL distilled water. This is the reagent blank.
7. Place tubes in preheated COD block heater and maintain temperature at 150±2°C for two hours.
8. At the end of the heating period turn the heater off. Wait 20 minutes for the tubes to cool to 120°C or less.
9. Remove tubes from block heater. Invert several times to mix.
10. Allow to cool to room temperature.
11. Press and hold ⏻ until colorimeter turns on.
12. Press ENTER to select **TESTING MENU**.
13. Select **ALL TESTS** (or another sequence containing **001 COD LR**) from PROGRAMMED TESTS menu.
14. Scroll to and select **001 COD LR** from menu.
15. Wipe the blank tube with a damp towel to remove fingerprints and smudges. Wipe with a dry towel.
16. Insert reagent blank tube into chamber. Select **SCAN BLANK**.
17. Remove tube from colorimeter.
18. Insert digested water sample tube into chamber. Select **SCAN SAMPLE**. Record result. For the most accurate results, take three readings on each sample and average the results.
19. Press ⏻ to turn colorimeter off or press EXIT to exit to a previous menu or make another menu selection.

NOTES: Reagents are light sensitive. Unused reagents should be stored in the shipping container, and in the refrigerator if possible, until needed.

A reagent blank should be run with each set of samples and with each lot of reagents.

The reacted blank will be stable if stored in the dark.

To eliminate error caused by contamination, wash all glassware with 20% sulfuric acid.

For greater accuracy, a minimum of three repetitions should be performed and the results averaged.

Some samples may be digested completely in less than two hours. The concentration may be measured at 15 minute intervals while the vials are still hot until the reading remains unchanged. The vials should be cooled to room temperature before the final measurement is taken.

COD – STANDARD RANGE

MERCURY FREE DIGESTION METHOD • CODE 0073-SC
MERCURY DIGESTION METHOD • CODE 0076-SC

QUANTITY	CONTENTS	CODE
25	*COD Standard Range Mercury Free Tubes	*0073-SC
or 25	*COD Standard Range Mercury Tubes	*0076-SC

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

COD Standard Range Mercury Free Tubes are not USEPA approved.

COD Standard Range Mercury Tubes are USEPA approved.

Equipment needed but not supplied:

1	COD Adapter	5-0087
1	COD Reactor, 12 tube, 110V	5-0102
or 1	COD Reactor, 12 tube, 230V	5-0102-EX2
1	Measuring Pipet, 1.0 mL	2-2110
1	Pipet Bulb	2-2164

Chemical Oxygen Demand (COD) is a measure of the amount of organic matter in water which is susceptible to oxidation by chemical oxidants. COD can be empirically related to the Biological Oxygen Demand (BOD) and organic carbon content of a specific source of water. This correlation must be determined experimentally for each source of water.

APPLICATION:	Domestic and industrial wastes.
RANGE:	0–1500 mg/L COD
MDL:	40 mg/L
METHOD:	Dichromate in the presence of silver salts, at high temperature in a closed system, oxidizes most organic compounds to 95-100% of the theoretical amount. This process is called digestion. As dichromate oxidizes the organic compounds, a green complex is formed. The concentration of the green complex is measured at 605 nm and is directly proportional to the COD of the sample.
SAMPLE HANDLING & PRESERVATION:	Collect samples in glass and test as soon as possible. If samples must be stored, preservation is accomplished by the addition of concentrated H_2SO_4 to adjust the pH below 2. Samples with suspended solids should be homogenized in a blender (100 mL for 30 seconds) and then stirred gently with a magnetic stirrer.
INTERFERENCES:	Volatile organic compounds are not oxidized to the extent that they are in the vapor above the digestion solution. Therefore, they do not contribute to the COD reading. Chloride concentrations above 10% of COD interfere with the mercury free tubes. Chloride above 2000 ppm will interfere with the mercury tubes. Nitrite gives a positive interference of 1.1 ppm O_2 per ppm NO_2–N which is insignificant unless nitrite concentrations are very high. Other reduced inorganic compounds are stoichiometrically oxidized, causing a positive interference. Corrections can be made for these compounds based upon their stoichiometry and concentrations. When scanning samples in 16 mm tubes, such as COD, the sample chamber lid can not be closed. Use the COD adapter to minimize stray light interference. To further reduce stray light interference, do not scan sample in direct sunlight.

PROCEDURE

Use COD/UDV adapter.

1. Homogenize sample if necessary.
2. Preheat COD heater block to 150±2°C.
3. Remove cap from COD tube. Hold tube at a 45° angle. Use a volumetric pipet, to carefully add 2.0 mL sample water allowing the sample to run down the side of the tube.
4. Cap and mix thoroughly.
5. Rinse the outside of the vial with distilled water. Wipe dry with a paper towel.
6. Repeat steps 2 through 5 using 2.0 mL distilled water. This is the reagent blank.
7. Place tubes in preheated COD block heater and maintain temperature at 150±2°C for two hours.
8. At the end of the heating period turn the heater off. Wait 20 minutes for the tubes to cool to 120°C or less.
9. Remove tubes from block heater. Invert several times to mix.
10. Allow to cool to room temperature.
11. Press and hold ⏻ until colorimeter turns on.
12. Press ENTER to select **TESTING MENU**.
13. Select **ALL TESTS** (or another sequence containing **002 COD SR**) from **TESTING MENU** menu.
14. Wipe the blank tube with a damp towel to remove fingerprints and smudges. Wipe with a dry towel.
15. Scroll to and select **002 COD SR** from menu.
16. Insert reagent blank tube into chamber. Select **SCAN BLANK**.
17. Remove tube from colorimeter.
18. Insert digested water sample tube into chamber. Select **SCAN SAMPLE**. Record result. For the most accurate results, take three readings on each sample and average the results.
19. Press ⏻ to turn colorimeter off or press EXIT to exit to a previous menu or make another menu selection.

NOTES: Reagents are light sensitive. Unused reagents should be stored in the shipping container, and in the refrigerator if possible, until needed.

A reagent blank should be run with each set of samples and with each lot of reagents.

The reacted blank will be stable if stored in the dark.

To eliminate error caused by contamination, wash all glassware with 20% sulfuric acid.

For greater accuracy, a minimum of three repetitions should be performed and the results averaged.

Some samples may be digested completely in less than two hours. The concentration may be measured at 15 minute intervals while the vials are still hot until the reading remains unchanged. The vials should be cooled to room temperature before the final measurement is taken.

COD – HIGH RANGE

MERCURY FREE DIGESTION METHOD • CODE 0074-SC
MERCURY DIGESTION METHOD • CODE 0077-SC

QUANTITY	CONTENTS	CODE
25	*COD High Range Mercury Free Tubes	*0074-SC
or 25	*COD High Range Mercury Tubes	*0077-SC

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

COD High Range Mercury Free Tubes and COD High Range Mercury Tubes are not USEPA approved.

Equipment needed but not supplied:

1	COD Adapter	5-0087
1	COD Reactor, 12 tube, 110V	5-0102
or 1	COD Reactor, 12 tube, 230V	5-0102-EX2
1	Measuring Pipet, 1.0 mL	2-2110
1	Pipet Bulb	2-2164

Chemical Oxygen Demand (COD) is a measure of the amount of organic matter in water which is susceptible to oxidation by chemical oxidants. COD can be empirically related to the Biological Oxygen Demand (BOD) and organic carbon content of a specific source of water. This correlation must be determined experimentally for each source of water.

APPLICATION:	Domestic and industrial wastes.
RANGE:	0–15000 mg/L COD
MDL:	400 mg/L
METHOD:	Dichromate in the presence of silver salts, at high temperature in a closed system, oxidizes most organic compounds to 95-100% of the theoretical amount. This process is called digestion. As dichromate oxidizes the organic compounds, a green complex is formed. The concentration of the green complex is measured at 605 nm and is directly proportional to the COD of the sample.
SAMPLE HANDLING & RESERVATION:	Collect samples in glass and test as soon as possible. If samples must be stored, preservation is accomplished by the addition of concentrated H2SO4 to adjust the pH below 2. Samples with suspended solids should be homogenized in a blender (100 mL for 30 seconds) and then stirred gently with a magnetic stirrer.
INTERFERENCES:	Volatile organic compounds are not oxidized to the extent that they are in the vapor above the digestion solution. Therefore, they do not contribute to the COD reading. Contains mercury sulfate to prevent interference from chloride. Nitrite gives a positive interference of 1.1 ppm O_2 per ppm NO_2–N, which is insignificant unless nitrite concentrations are very high. Other reduced inorganic compounds are stoichiometrically oxidized, causing a positive interference. Corrections can be made for these compounds based upon their stoichiometry and concentrations. When scanning samples in 16 mm tubes, such as COD, the sample chamber lid can not be closed. Use the COD adapter to minimize stray light interference. To further reduce stray light interference, do not scan sample in direct sunlight.

PROCEDURE

Use COD/UDV adapter.

1. Homogenize sample if necessary.
2. Preheat COD heater block to 150±2°C.
3. Remove cap from COD tube. Hold tube at a 45° angle. Use a graduated pipet, to carefully add 0.2 mL sample water allowing the sample to run down the side of the tube.
4. Cap and mix thoroughly.
5. Rinse the outside of the tube with distilled water. Wipe dry with a paper towel.
6. Repeat steps 3 through 5 using 0.2 mL distilled water. This is the reagent blank.
7. Place tubes in preheated COD block heater and maintain temperature at 150±2°C for two hours.
8. At the end of the heating period turn the heater off. Wait 20 minutes for the tubes to cool to 120°C or less.
9. Remove tubes from block heater. Invert several times to mix.
10. Allow to cool to room temperature.
11. Press and hold ⏻ until colorimeter turns on.
12. Press ENTER to select **TESTING MENU**.
13. Select **ALL TESTS** (or another sequence containing **003 COD HR**) from TESTING MENU menu.
14. Wipe the blank tube with a damp towel to remove fingerprints and smudges. Wipe with a dry towel.
15. Scroll to and select **003 COD HR** from menu.
16. Insert reagent blank tube into chamber. Select **SCAN BLANK**.
17. Remove tube from colorimeter.
18. Insert digested water sample tube into chamber. Select **SCAN SAMPLE**. Record result. For the most accurate results, take three readings on each sample and average the results.
19. Press ⏻ to turn colorimeter off or press EXIT to exit to a previous menu or make another menu selection.

NOTES: Reagents are light sensitive. Unused reagents should be stored in the shipping container, and in the refrigerator if possible, until needed.

A reagent blank should be run with each set of samples and with each lot of reagents.

The reacted blank will be stable if stored in the dark.

To eliminate error caused by contamination, wash all glassware with 20% sulfuric acid.

For greater accuracy, a minimum of three repetitions should be performed and the results averaged.

AMMONIA NITROGEN - LOW RANGE

SALICYLATE METHOD • CODE 3659-01-SC

QUANTITY	CONTENTS	CODE
60 mL	*Salicylate Ammonia #1	*3978-H
10 g	*Salicylate #2	*7457-D
2 x 5 g	*Salicylate #3 Reagent Powder	*7458-C
1	Spoon, 0.1 g, plastic	0699
1	Spoon, 0.15 g, plastic	0727
1	Pipet, 1.0 mL, plastic	0354

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

Ammonia nitrogen is present in various concentrations in many surface and ground water supplies. Any sudden change in the concentration of ammonia nitrogen in a water supply is cause for suspicion. A product of microbiological activity, ammonia nitrogen is sometimes accepted as chemical evidence of pollution when encountered in natural waters.

Ammonia is rapidly oxidized in natural water systems by special bacterial groups that produce nitrite and nitrate. This oxidation requires that dissolved oxygen be available in the water. Ammonia is an additional source of nitrogen as a nutrient which may contribute to the expanded growth of undesirable algae and other forms of plant growth that overload the natural system and cause pollution.

APPLICATION:	Low concentrations of ammonia in fresh, brackish and salt water; fresh and salt water aquariums.
RANGE:	0.00 - 1.00 ppm Ammonia-Nitrogen
MDL:	0.05 ppm Fresh Water 0.10 ppm Salt Water
METHOD:	Salicylate and ammonia react at high pH in the presence of a chlorine donor and an iron catalyst to form a blue indophenol dye, the concentration of which is proportional to the ammonia concentration in the sample.
SAMPLE HANDLE & PRESERVATION:	Ammonia solutions tend to be unstable and should be analyzed immediately. Samples may be stored for 24 hours at 4°C or 28 days at –20°C.
INTERFERENCES:	There are few interferences in most natural waters. High concentrations of reducing agents, such as hydrazine, react with the chlorine donor and can result in negative interferences. Color and turbidity can also interfere.

PROCEDURE - FRESH WATER

1. Press and hold ⏻ until colorimeter turns on.
2. Press ENTER to select **TESTING MENU**.
3. Select **ALL TESTS** (or another sequence containing **004 Ammonia-N LRF**) from **TESTING MENU**.
4. Scroll to and select **004 Ammonia-N LRF** from menu.
5. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
6. Insert tube into chamber, close lid and select **SCAN BLANK**. (See Note.)
7. Remove tube from colorimeter. Use the 1.0 mL plastic pipet (0354) to add 2.0 mL of *Salicylate Ammonia #1 (3978). Cap and mix.
8. Use the 0.15 g spoon (0727) to add two measures of *Salicylate #2 Reagent (7457). Cap and mix until dissolved. Wait 1 minute.
9. At end of 1 minute waiting period use 0.1 g spoon (0699) to add two measures of *Salicylate #3 Reagent Powder (7458). Cap and shake vigorously for at least 30 seconds and all solid has dissolved. Wait 12 minutes for maximum color development.
10. At the end of the 12 minute waiting period, immediately mix and insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
11. Press ⏻ to turn colorimeter off or press EXIT to exit to a previous menu or make another menu selection.

CALCULATIONS:

To express results as Unionized Ammonia (NH_3):

ppm Unionized Ammonia (NH_3) =
ppm Ammonia-Nitrogen (NH_3–N) x 1.2

To express results as Ionized Ammonia (NH_4):

ppm Ionized Ammonia (NH_4^+) =
ppm Ammonia-Nitrogen (NH_3–N) x 1.3

To determine the percentages of Unionized and Ionized Ammonia-Nitrogen, consult the Appendix.

NOTE: It is strongly suggested that a reagent blank be determined to account for any contribution to the test result by the reagent system. To determine the reagent blank, follow the above test procedure to scan a distilled or deionized water blank. Then follow the above procedure to perform the test on a distilled or deionized water sample. This test result is the reagent blank. Subtract the reagent blank from all subsequent test results of unknown samples. It is necessary to determine the reagent blank only when a new lot number of reagents is obtained.

PROCEDURE - SALT WATER

1. Press and hold ⏻ until colorimeter turns on.
2. Press ENTER to select TESTING MENU.
3. Select **ALL TESTS** (or another sequence containing **005 Ammonia-N LRS**) from TESTING MENU.
4. Scroll to and select **005 Ammonia-N LRS** from menu.
5. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
6. Insert tube into chamber, close lid and select **SCAN BLANK**. (See Note.)
7. Remove tube from colorimeter. Use the 1.0 mL plastic pipet (0354) to add 2.0 mL of *Salicylate Ammonia #1 (3978). Cap and mix.
8. Use the 0.15 g spoon (0727) to add two measures of *Salicylate #2 Reagent (7457). Cap and mix until dissolved. Wait 1 minute.
9. At end of 1 minute waiting period use 0.1 g spoon (0699) to add two measures of *Salicylate #3 Reagent Powder (7458). Cap and shake vigorously for at least 30 seconds and all solid has dissolved. Wait 20 minutes for maximum color development.
10. At the end of the 20 minute waiting period, immediately mix and insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
11. Press ⏻ to turn colorimeter off or press EXIT to exit to a previous menu or make another menu selection.

CALCULATIONS:

To express results as Unionized Ammonia (NH_3):

ppm Unionized Ammonia (NH_3) =
ppm Ammonia-Nitrogen (NH_3–N) x 1.2

To express results as Ionized Ammonia (NH_4):

ppm Ionized Ammonia (NH_4^+) =
ppm Ammonia-Nitrogen (NH_3–N) x 1.3

To determine the percentages of Unionized and Ionized Ammonia-Nitrogen, consult the Appendix.

NOTE: It is strongly suggested that a reagent blank be determined to account for any contribution to the test result by the reagent system. To determine the reagent blank, follow the above test procedure to scan a distilled or deionized water blank. Then follow the above procedure to perform the test on a distilled or deionized water sample. This test result is the reagent blank. Subtract the reagent blank from all subsequent test results of unknown samples. It is necessary to determine the reagent blank only when a new lot number of reagents is obtained.

AMMONIA NITROGEN - HIGH RANGE

NESSLERIZATION METHOD •CODE 3642-SC

QUANTITY	CONTENTS	CODE
30 mL	Ammonia Nitrogen Reagent #1	V-4797-G
2 x 30 mL	*Ammonia Nitrogen Reagent #2	*V-4798-G
1	Pipet, 1 mL, plastic	0354

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

Ammonia nitrogen is present in various concentrations in many surface and ground water supplies. Any sudden change in the concentration of ammonia nitrogen in a water supply is cause for suspicion. A product of microbiological activity, ammonia nitrogen is sometimes accepted as chemical evidence of pollution when encountered in natural waters.

Ammonia is rapidly oxidized in natural water systems by special bacterial groups that produce nitrite and nitrate. This oxidation requires that dissolved oxygen be available in the water. Ammonia is an additional source of nitrogen as a nutrient which may contribute to the expanded growth of undesirable algae and other forms of plant growth that overload the natural system and cause pollution.

APPLICATION:	Drinking, surface, and saline waters; domestic and industrial wastes.
RANGE:	0.00–4.00 ppm Ammonia Nitrogen
MDL:	0.05 ppm
METHOD:	Ammonia forms a colored complex with Nessler's Reagent in proportion to the amount of ammonia present in the sample. Rochelle salt is added to prevent precipitation of calcium or magnesium in undistilled samples.
SAMPLE HANDLING & PRESERVATION:	Ammonia solutions tend to be unstable and should be analyzed immediately. Sample may be stored for 24 hours at 4°C or 28 days at –20°C.
INTERFERENCES:	Sample turbidity and color may interfere. Turbidity may be removed by a filtration procedure. Color interference may be eliminated by blanking the instrument with a sample blank.

PROCEDURE

1. Press and hold ⏻ until colorimeter turns on.
2. Press ENTER to select **TESTING MENU**.
3. Scroll to and select **ALL TESTS** (or another sequence containing **006 Ammonia-N HR**) from **TESTING MENU**.
4. Scroll to and select **006 Ammonia-N HR** from menu.
5. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
6. Insert tube into chamber, close lid and select **SCAN BLANK**. (See Note)
7. Remove tube from colorimeter. Add 8 drops of Ammonia Nitrogen Reagent #1 (V-4797). Cap and mix. Wait 1 minute.
8. Use the 1.0 mL pipet (0354) to add 1.0 mL of *Ammonia Nitrogen Reagent #2 (V-4798). Cap and mix. Allow 5 minutes for maximum color development.
9. At end of the 5 minute waiting period, immediately mix, insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
10. Press ⏻ to turn the colorimeter off or press the EXIT exit to a previous menu or make another menu selection.

CALCULATIONS:

To express results as Unionized Ammonia (NH_3):

ppm Unionized Ammonia (NH_3) =
ppm Ammonia-Nitrogen (NH_3–N) x 1.2

To express results as Ionized Ammonia (NH_4):

ppm Ionized Ammonia (NH_4^+) =
ppm Ammonia-Nitrogen (NH_3–N) x 1.3

To determine the percentages of Unionized and Ionized Ammonia-Nitrogen, consult the Appendix.

NOTE: It is strongly suggested that a reagent blank be determined to account for any contribution to the test result by the reagent system. To determine the reagent blank, follow the above test procedure to scan a distilled or deionized water blank. Then follow the above procedure to perform the test on a distilled or deionized water sample. This test result is the reagent blank. Subtract the reagent blank from all subsequent test results of unknown samples. It is necessary to determine the reagent blank only when a new lot number of reagents is obtained.

BORON

AZOMETHINE-H METHOD · CODE 4868-01

QUANTITY	CONTENTS	CODE
120 mL	*Boron Buffer	*4869-J
10 g	*Boron Indicator Powder	*4870-D
1	Pipet, plastic, 1.0 mL	0354
1	Spoon, 0.15 g	0727
1	Dark storage chamber, brown	0108

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

Small amounts of boron are necessary for plant growth but large amounts can be toxic. In humans, boron aids in the uptake of calcium and the production of strong bones. An excess of boron can affect the central nervous system resulting in a syndrome known as borism. Some natural waters may contain small amounts of boron. Large concentrations may be due to industrial effluent entering waterways. Boron compounds are used in cleaning compounds, paper and paints, fertilizers, glass and ceramics, fire retardants and the production of alloys. In the atomic energy field, boron is a component of neutron shields and nuclear reactors. Some swimming pools use boron buffering systems.

APPLICATION:	Surface and saline waters, hydroponic solutions, industrial waste, swimming pools.
RANGE:	0.00–0.80 ppm Boron
MDL:	0.05
METHOD:	Azomethine-H and borate form a yellow complex at pH 6 in proportion to the concentration of boron present.
SAMPLE HANDLING & PRESERVATION:	Store samples in polyethylene bottles. Do not use borate detergents or glassware.
INTERFERENCES:	Interferences in drinking water are unlikely. Manganese, zirconium, chromium, titanium, copper, vanadium, aluminum, beryllium and iron may cause high results.

PROCEDURE

1. This test requires a Reagent Blank. Rinse a tube (0290) with clear, colorless, boron free water. Fill to 10 mL line with clear, colorless, boron free water.
2. Use the 1.0 mL pipet (0354) to add 2 mL of *Boron Buffer (4869). Cap and mix.
3. Use the 0.15 g spoon (0727) to add one level measure of *Boron Indicator Powder (4870). Press full spoon against side of jar to compress powder. Scrape off excess powder on inside neck of bottle. Tap excess off spoon handle.
4. Cap and shake vigorously for 30 seconds.
5. Insert the tube into meter chamber. Close lid.
6. Start a timer set for 30 minutes. Do not open the lid during the waiting time. The reaction is photosensitive.
7. Rinse a clean tube (0290) with Sample Water. Fill to the 10 mL line with sample water. Repeat steps 2–4.
8. Insert the tube into the Dark Storage Chamber (0108). Close top.
9. Start a second timer set for 30 minutes. Do not open the chamber during the waiting time. The reaction is photosensitive.
10. When 2 minutes remain on the first timer (Reagent Blank), press and hold ON button until colorimeter turns on.
11. Press and hold ⏻ until colorimeter turns on.
12. Press ENTER to select **TESTING MENU**.
13. Select **ALL TESTS** (or another sequence containing **007 Boron**) from **TESTING MENU**.
14. Scroll to and select **007 Boron** from menu.At the end of the Reagent Blank 30 minute waiting period, remove Reagent Blank tube from meter chamber. Invert several times to mix.
15. Insert the tube into meter chamber, close lid and select SCAN BLANK.
16. Remove the tube from colorimeter.
17. At the end of the Sample Water 30 minute waiting period, remove Sample Water tube from Dark Storage Chamber. Invert several times to mix.
18. Insert tube into meter chamber, close lid and select SCAN SAMPLE. Record result in ppm boron.
19. Press ⏻ to turn colorimeter off or press the EXIT to exit to a previous menu or make another menu selection.

COBALT

PAN METHOD · CODE 4851

QUANTITY	CONTENTS	CODE
60 mL	*Cobalt Buffer	*4852-H
60 mL	*Cobalt Indicator Reagent	*4853-H
30 mL	*Stabilizer Solution	*4854-G
2	Pipet, 1.0 mL, plastic	0354
1	Pipet, 0.5 mL, plastic	0353

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Cobalt rarely occurs in natural water. It is used in the manufacture of alloys to increase corrosion resistance and strength. It is found in wastewaters as a corrosion by-product.

APPLICATION:	Industrial wastewater.
RANGE:	0.00–2.00 ppm Cobalt
MDL:	0.04 ppm
METHOD:	PAN (1-[2-Pyridylazo]-2-Naphthol) forms a greenish complex with Cobalt (Co^{+2}) at a pH of 5.
SAMPLE HANDLING & PRESERVATION:	Store samples in acid-washed plastic bottles. Adjust pH to less than 2 with nitric acid. Adjust sample pH to 5 before testing.
INTERFERENCES:	Iron (+2) and high concentrations of heavy metals.

PROCEDURE

1. Press and hold  until colorimeter turns on.
2. Press  to select **TESTING MENU**.
3. Select **ALL TESTS** (or another sequence containing **008 Cobalt**) from TESTNG MENU.
4. Scroll to and select **008 Cobalt** from menu.
5. Rinse a tube (0290) with sample water. Fill to 10 mL with sample.
6. Insert the tube into chamber, close lid and select **SCAN BLANK**.
7. Remove the tube from colorimeter.
8. Use the 1.0 mL pipet (0354) to add 1 mL of *Cobalt Buffer (4852). Cap and mix.
9. Use the other 1.0 mL pipet (0354) to add 1 mL of *Cobalt Indicator Reagent (4853). Cap and mix.
10. Wait 3 minutes.
11. Use the 0.5 mL pipet (0353) to add 0.5 mL *Stabilizer Solution (4854). Cap and invert 15 times to thoroughly mix.
12. Wait 5 minutes. DO NOT MIX.
13. Insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result in ppm cobalt.
14. Press  to turn the colorimeter off or press  to exit to a previous menu or make another menu selection.

NOTE: For best possible results, a reagent blank should be determined to account for any contribution to the test result by the reagent system. To determine the reagent blank, follow the above test procedure to scan a distilled or deionized water blank. Then follow the above procedure to perform the test on a distilled or deionized water sample. This test result is the reagent blank. Subtract the reagent blank from all subsequent test results of unknown samples. It is necessary to determine the reagent blank only when a new lot number of reagents is obtained.

COLOR

PLATINUM COBALT METHOD
NO REAGENTS REQUIRED

Color in water may be attributed to humus, peat, plankton, vegetation, and natural metallic ions, such as iron and manganese, or industrial waste. Color is removed to make water suitable for domestic and industrial use. Color may have to be removed from industrial waste before it is discharged to a waterway.

APPLICATION:	Potable water and water with color due to natural materials.
RANGE:	0–1000 color units
MDL:	20 Cu
METHOD:	Color is determined by a meter that has been calibrated with colored standards of known platinum cobalt concentration. True color, the color of water in which the turbidity has been removed, is measured.
SAMPLE HANDLING & PRESERVATION:	Collect all samples in clean glassware. Determine color as soon as possible to avoid biological or chemical changes that could occur in the sample during storage.
INTERFERENCES:	Turbidity will interfere. Filter before testing.

PROCEDURE

1. Press and hold  until colorimeter turns on.
2. Press  to select **TESTING MENU**.
3. Select **ALL TESTS** (or another sequence containing **009 Color**) from **TESTING MENU**.
4. Scroll to and select **009 Color** from menu.
5. Rinse a tube (0290) with color-free water (distilled or deionized water). Fill to 10 mL line with color-free water.
6. Insert the tube into chamber, close lid and select **SCAN BLANK**.
7. Remove tube from colorimeter. Empty tube.
8. Rinse tube with sample water. Fill to 10 mL line with water sample.
9. Insert tube with sample water, close lid and select **SCAN SAMPLE**. Record result in color units.
10. Press  to turn the colorimeter off or press  to exit to a previous menu or make another menu selection.

COPPER

CUPRIZONE METHOD • CODE 4023

QUANTITY	CONTENTS	CODE
15 mL	Copper A	P-6367-E
15 mL	*Copper B	*P-6368-E

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The copper content of drinking water generally falls below 0.03 parts per million, but copper levels as high as 1.0 part per million will give water a bitter taste. Waters testing as high as 1.0 part per million copper have probably been treated with a copper compound, like those used in the control of algae, or have become contaminated from untreated industrial wastes. The addition of copper sulfate to lakes causes an increase in the copper content of the sediments. Acid waters and those high in free carbon dioxide may cause the corrosion or “eating away” of copper, brass and bronze pipes and fittings. This corrosion results in the addition of copper to the water supply.

APPLICATION:	Drinking, surface, and domestic waters. Pools and spas.
RANGE:	0.00–2.50 ppm Copper
MDL:	0.03 ppm
METHOD:	Copper ions form a blue complex with cuprizone, in a 1 to 2 ratio, at a pH of about 8, in proportion to the concentration of copper in the sample.
SAMPLE HANDLING & PRESERVATION:	Copper has a tendency to be adsorbed to the surface of the sample container. Samples should be analyzed as soon as possible after collection. If storage is necessary, 0.5 mL of 20% hydrochloric acid per 100 mL of sample will prevent “plating out”. However, a correction must be made to bring the reaction into the optimum pH range.
INTERFERENCES:	Hg^{+1} at 1 ppm. Cr^{+3}, Co^{+2}, and silicate at 10 ppm. As^{+3}, Bi^{+3}, Ca^{+2}, Ce^{+3}, Ce^{+4}, Hg^{+2}, Fe^{+2}, Mn^{+2}, Ni^{+2} and ascorbate at 100 ppm. Many other metal cations and inorganic anions at 1000 ppm. EDTA at all concentrations.

PROCEDURE

1. Press and hold ⏻ until colorimeter turns on.
2. Press ENTER to select **TESTING MENU**.
3. Select **ALL TESTS** (or another sequence containing **010 Cu Cuprizone**) from **TESTING MENU**.
4. Scroll to and select **010 Cu Cuprizone** from menu.
5. Rinse a tube (0290) with sample water. Fill to the 10 mL line with sample.
6. Insert the tube into chamber, close lid and select **SCAN BLANK**.
7. Remove tube from colorimeter and add 5 drops of Copper A (6367). Cap and mix.
8. Add 5 drops of *Copper B (6368). Cap and mix.
9. Wait 5 minutes. Mix.
10. Insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
11. Press ⏻ to turn the colorimeter off or press EXIT to exit to a previous menu or make another menu selection.

NOTE: For best possible results, a reagent blank should be determined to account for any contribution to the test result by the reagent system. To determine the reagent blank, follow the above test procedure to scan a distilled or deionized water blank. Then follow the above procedure to perform the test on a distilled or deionized water sample. This test result is the reagent blank. Subtract the reagent blank from all subsequent test results of unknown samples. It is necessary to determine the reagent blank only when a new lot number of reagents are obtained.

The reaction may stain the tubes. Scrub tubes thoroughly after each use.

COPPER

DIETHYLDITHIOCARBAMATE METHOD • CODE 3646-SC

QUANTITY	CONTENTS	CODE
15 mL	*Copper 1	*6446-E

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The copper content of drinking water generally falls below 0.03 parts per million, but copper levels as high as 1.0 part per million will give water a bitter taste. Waters testing as high as 1.0 part per million copper have probably been treated with a copper compound, like those used in the control of algae, or have become contaminated from untreated industrial wastes. The addition of copper sulfate to lakes causes an increase in the copper content of the sediments. Acid waters and those high in free carbon dioxide may cause the corrosion or “eating away” of copper, brass and bronze pies and fittings. This corrosion results in the addition of copper into the water supply.

APPLICATION:	Drinking, surface, and saline waters; domestic and industrial wastes.
RANGE:	0.00–7.00 ppm Copper
MDL:	0.10 ppm
METHOD:	Copper ions form a yellow colored chelate with diethyldithiocarbamate around pH 9-10 in proportion to the concentration of copper in the sample.
SAMPLE HANDLING & PRESERVATION:	Copper has a tendency to be adsorbed to the surface of the sample container. Samples should be analyzed as soon as possible after collection. If storage is necessary, 0.5 mL of 20% hydrochloric acid per 100 mL of sample will prevent “plating out.” However, a correction must be made to bring the reaction into the optimum pH range.
INTERFERENCES:	Bismuth, cobalt, mercurous, nickel and silver ions and chlorine (6 ppm or greater) interfere and must be absent.

PROCEDURE

1. Press and hold  until colorimeter turns on.
2. Press  to select **TESTING MENU**.
3. Select **ALL TESTS** (or another sequence containing **011 Cu Thiocarbamate**) from **TESTING MENU**.
4. Scroll to and select **011 Cu Thiocarbamate** from menu.
5. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
6. Insert tube into chamber, close lid and select **SCAN BLANK**.
7. Remove tube from colorimeter and add 5 drops of *Copper 1 (6446). Cap and mix. Solution will turn yellow if copper is present.
8. Insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
9. Press  to turn colorimeter off or press  to exit to a previous menu or make another menu selection.

NOTE: The reaction may stain the tubes. Scrub the tubes thoroughly after each use.

CYANURIC ACID

MELAMINE METHOD–TURBIDITY • CODE 366I-01-SC

QUANTITY	CONTENTS	CODE
2 x 100 mL	*Cyanuric Acid Test Solution	*4856-J
1	Syringe, 5 mL	0807

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

Cyanuric acid is added to swimming pool water as a stabilizing agent for free chlorine residuals. It minimizes the loss of chlorine from the action of ultraviolet rays in sunlight. Cyanuric acid levels in pools should be maintained between 25 and 75 ppm and various public health associations recommend that the concentration should never exceed 100-150 ppm.

APPLICATION:	Swimming pool waters.
RANGE:	5–200 ppm Cyanuric Acid
MDL:	10 ppm
METHOD:	A buffered solution of melamine forms a precipitate with cyanuric acid in proportion to the amount of cyanuric acid present. The amount of particles in suspension is measured turbidimetrically.
SAMPLE HANDLING & PRESERVATION:	Cyanuric acid samples should be analyzed as soon as possible after collection. Deterioration of the sample can be minimized by keeping samples in the dark or refrigerated until analysis can be performed.
INTERFERENCES:	No known interference from compounds normally found in pool water. Temperature of the sample should be maintained between 70°F and 80°F for best results. Check for stray light interference (see p. 69).

PROCEDURE

1. Press and hold ⏻ until colorimeter turns on.
2. Press ENTER to select **TESTING MENU**.
3. Select **ALL TESTS** (or another sequence containing **012 Cyanuric Acid**) from **TESTING MENU**.
4. Scroll to and select **012 Cyanuric Acid** from menu.
5. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
6. Insert tube into chamber, close lid and select **SCAN BLANK**.
7. Remove tube from colorimeter and pour out water. Use a graduated cylinder or similar to measure 5 mL of sample water and pour into colorimeter tube.
8. Use the 5 mL syringe (0807) to add 5 mL of *Cyanuric Acid Test Solution (4856). Cap and mix thoroughly. A precipitate will form if cyanuric acid is present. Wait 1 minute.

   NOTE: This reagent bottle has a special fitting which enables the syringe to be inserted into the top of the bottle. With syringe in place, invert bottle and withdraw syringe plunger until 5 mL of reagent is contained in the syringe barrel. Remove syringe from reagent bottle and depress plunger to dispense into the tube.
9. At end of 1 minute waiting period, mix thoroughly, insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
10. Press ⏻ to turn colorimeter off or press EXIT to exit to a previous menu or make another menu selection.

NOTE: For the most accurate results, the sample and reagents should be at 25 ±4°C.

DISSOLVED OXYGEN

WINKLER COLORIMETRIC METHOD • CODE 3688-SC

QUANTITY	CONTENTS	CODE
30 mL	*Manganese Sulfate Solution	*4167-G
30 mL	*Alkaline Potassium Iodide Azide	*7166-G
30 mL	*Sulfuric Acid 1:1	*6141WT-G
1	Sample Tube, screw cap	29180
1	Cap	28570

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Dissolved oxygen is vital to the survival of aquatic organisms. Naturally present, dissolved oxygen enters the water when plants photosynthesize. Wind and wave action also cause oxygen from the air to dissolve into water. Dissolved oxygen is consumed by aquatic animals and by the oxidation, or chemical breakdown, of dead and decaying plants and animals. The concentration of dissolved oxygen in natural waters can range from 0 to 14 ppm and is effected by temperature and salinity.

APPLICATION:	This method is applicable for the determination of dissolved oxygen in drinking water, all surface waters and wastewater.
MDL:	0.6 ppm
RANGE:	0.0–10.0 Dissolved Oxygen
METHOD:	This method uses the azide modification of the Winkler Method with a colorimetric determination of the yellow iodine produced from the reaction with the dissolved oxygen.
INTERFERENCES:	The presence of other oxidizing agents may cause positive interferences. Reducing may cause negative interferences. Nitrite interferences are eliminated with the azide modification.

COLLECTION & TREATMENT OF THE WATER SAMPLE

Steps 1 through 4 below describe proper sampling technique in shallow water. For sample collection at depths beyond arm's reach, special water sampling apparatus is required (e.g. the LaMotte Water Sampling Chamber, Code 1060; Model JT-1 Water Samplers, Code 1077; Water Sampling Outfit, Code 3103; or Water Sampling Bottle, Code 3-0026).

1. To avoid contamination, thoroughly rinse the screw cap Sample Tube (29180) with sample water.
2. Tightly cap Sample Tube and submerge to the desired depth. Remove cap and allow the Sample Tube to fill.
3. Tap the sides of the submerged tube to dislodge any air bubbles clinging to the inside. Replace the cap while the Sample Tube is still submerged.
4. Retrieve Sample Tube and examine it carefully to make sure that no air bubbles are trapped inside. Once a satisfactory sample has been collected, proceed immediately with Steps 5 and 6 to "fix" the sample.

   NOTE: Be careful not to introduce air into the sample while adding the reagents in steps 5 and 6. Simply drop the reagents into the sample. Cap carefully, and mix gently.
5. Add 2 drops of *Manganese Sulfate Solution (4167) and 2 drops of *Alkaline Potassium Iodide Azide (7166). Cap and mix by inverting several times. A precipitate will form. Allow the precipitate to settle below the shoulder of the tube before proceeding.
6. Add 8 drops of *Sulfuric Acid, 1:1 (6141WT). Cap and gently mix until the precipitate has dissolved. A clear-yellow to brown-orange color will develop, depending on the oxygen content of the sample.

NOTE: It is very important that all "brown flakes" are dissolved completely. If the water has a high DO level this could take several minutes. If flakes are not completely dissolved after 5 minutes, add 2 drops of *Sulfuric Acid 1:1 (6141WT) and continue mixing.

NOTE: Following the completion of step 6, contact between the water sample and the atmosphere will not affect the test result. Once the sample has been "fixed" in this manner, it is not necessary to perform the actual test procedure immediately. Thus, several samples can be collected and "fixed" in the field, and then carried back to a testing station or laboratory where the test procedure is to be performed.

PROCEDURE

1. Press and hold ⏻ until colorimeter turns on.
2. Press ENTER to select **TESTING MENU**.
3. Select **ALL TESTS** (or another sequence containing **013 Disolved Oxygen**) from TESTING MENU.
4. Scroll to and select **013 Disolved Oxygen** from menu.
5. Rinse a clean tube (0290) with untreated sample water. Fill to the 10 mL line with sample. This tube is the BLANK.
6. Insert tube into chamber, close lid and select **SCAN BLANK**.
7. Fill a second tube (0290) to the 10 line with the treated “Fixed” sample. This tube is the SAMPLE.
8. Remove BLANK from colorimeter, insert SAMPLE tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
9. Press ⏻ to turn colorimeter off or press EXIT to exit to a previous menu or make another menu selection.

FLUORIDE

SPADNS METHOD • CODE 3647-02-SC

QUANTITY	CONTENTS	CODE
4 x 30 mL	*Acid Zirconyl SPADNS Reagent	*3875-G
2 x 30 mL	*Sodium Arsenite Solution	*4128-G
1	Pipet, 0.5 mL, plastic	0353
1	Pipet, 1.0 mL, plastic	0354

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Fluoride may occur naturally in some ground waters or it may be added to public drinking water supplies to maintain a 1.0 mg/L concentration to prevent dental cavities. At higher concentrations, fluoride may produce an objectionable discoloration of tooth enamel called fluorosis, though levels up to 8 mg/L have not been found to be physiologically harmful.

NOTE: This procedure uses the EPA approved Reagent System for fluoride found in method 4500-F-D, 18th Edition of Standard Methods, pp. 1-27.

APPLICATION	Drinking and surface waters; domestic and industrial waters.
RANGE:	0.00–2.00 ppm Fluoride
MDL:	0.10 ppm
METHOD:	Colorimetric test based upon the reaction between fluoride and zirconium dye lake. The fluoride reacts with the dye lake, dissociating a portion of it into a colorless complex ion and dye. As the fluoride concentration increases, the color produced becomes progressively lighter. Samples may be stored and refrigerated in plastic containers.
SAMPLE HANDLING & PRESERVATION:	
INTERFERENCES:	The following substances produce a positive interference at the concentration given: Chloride (Cl^-) 7000 mg/L Phosphate (PO_4^{-3}) 16 mg/L $(NaPO_3)_6$ 1 mg/L

The following substances produce a negative interference at the concentration given:

Alkalinity ($CaCO_3$)	5000 mg/L
Aluminum (Al^{3+})	0.1 mg/L
Iron (Fe^{3+})	10 mg/L
Sulfate (SO_4^{-2})	200 mg/L

Color and turbidity must be removed or compensated for in the procedure. Temperature should be maintained within 5°C of room temperature.

PROCEDURE

1. Press and hold ⏻ until colorimeter turns on.
2. Press ENTER to select **TESTING MENU**.
3. Select **ALL TESTS** (or another sequence containing **014 Fluoride**) from **TESTING MENU**.
4. Scroll to and select **014 Fluoride** from menu.
5. This test requires a reagent blank. Rinse a clean tube (0290) with clear, colorless, fluoride free water. Fill to the 10 mL line with clear, colorless, fluoride free water.
6. Use the 0.5 mL pipet (0353) to add 0.5 mL of *Sodium Arsenite Solution (4128). Cap and mix.
7. Use the 1.0 mL pipet (0354) to add 2 measures of *Acid-Zirconyl SPADNS Reagent (3875). Cap and mix thoroughly. (This is the reagent blank.)
8. Insert tube into chamber, close lid and select **SCAN BLANK**.
9. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample water. Repeat steps 7 and 8.
10. Insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
11. Press ⏻ to turn colorimeter off or press EXIT to exit to a previous menu or make another menu selection.

HYDRAZINE

p-DIMETHYLAMINOBENZALDEHYDE METHOD
CODE 3656-01-SC

QUANTITY	CONTENTS	CODE
2 x 60 mL	*Hydrazine Reagent A	*4841-H
10 g	*Hydrazine Reagent B Powder	*4842-D
1	Pipet, 1.0 mL, plastic	0354
1	Spoon, 0.15 g, plastic	0727

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Hydrazine, N_2H_4, is added to the water in high pressure boilers to reduce corrosion by acting as an oxygen scavenger.

APPLICATION:	Water and boiler water, industrial waste water.
RANGE:	0.00–1.00 ppm Hydrazine
MDL:	0.01 ppm
METHOD:	p-Dimethylaminobenzaldehyde reacts with hydrazine under acidic conditions to form a yellow color in proportion to the amount of hydrazine present.
SAMPLE HANDLING & PRESERVATION:	Samples should be analyzed as soon as possible after collection due to the ease with which hydrazine becomes oxidized. Acidification of the sample may increase the time between collection and analysis.
INTERFERENCES:	The substances normally present in water do not interfere with the test, with the exception of strong oxidizing agents.

PROCEDURE

1. Press and hold  until colorimeter turns on.
2. Press  to select **TESTING MENU**.
3. Select **ALL TESTS** (or another sequence containing **015 Hydrazine**) from **TESTING MENU**.
4. Scroll to and select **015 Hydrazine** from menu.
5. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
6. Insert tube into chamber, close lid and select **SCAN BLANK**.
7. Remove tube from colorimeter. Use the 1 mL pipet (0354) to add 4 mL of *Hydrazine Reagent A (4841). Cap and mix.
8. Use the 0.15 g spoon (0727) to add one measure of *Hydrazine Reagent B Powder (4842). Cap and shake vigorously for 10 seconds. Wait 2 minutes for maximum color development. An undissolved portion of Hydrazine Reagent B may remain in bottom of tube without adversely affecting results.
9. At the end of the 2 minute waiting period, mix, insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
10. Press  to turn colorimeter off or press  to exit to a previous menu or make another menu selection.

NOTE: For best possible results, a reagent blank should be determined to account for any contribution to the test result by the reagent system. To determine the reagent blank, follow the above test procedure to scan a distilled or deionized water blank. Then follow the above procedure to perform the test on a distilled or deionized water sample. This test result is the reagent blank. Subtract the reagent blank from all subsequent test results of unknown samples. It is necessary to determine the reagent blank only when a new lot number of reagents is obtained.

MOLYBDENUM – HIGH RANGE

THIOGLYCOLATE METHOD • CODE 3699-03-SC

QUANTITY	CONTENTS	CODE
2 x 30 mL	*Mo Buffer	*3997-G
2 x 30 mL	*Molybdenum Oxidizing Reagent	*6485-G
2.5g	*Molybdenum Indicator Powder	*6486-S
1	Spoon, 0.05g, plastic	0696
2	Pipets, 1.0 mL, plastic w/cap	0372

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

Molybdenum occurs naturally in the earth's crust as molybdenite and wolfenite, and is an important element in many biochemical reactions, including nitrogen fixation. In industrial processes, such as the operation of boilers and cooling towers, molybdenum, in the form of sodium molybdate, is used as a corrosion inhibitor.

APPLICATIONS:	Boiler and cooling water.
RANGE:	0.0–50.0 ppm Molybdenum
MDL:	0.6 ppm
METHOD:	Calcium thioglycolate reacts with molybdenum to give a yellow color with an intensity proportional to the amount of molybdenum present.
SAMPLE HANDLING & PRESERVATION:	Molybdenum samples may be stored in either plastic or glass containers.
INTERFERENCES:	Nickel levels less than 50 ppm do not interfere; aluminum levels less than 10 ppm do not interfere; chromate at higher concentrations interferes due to the intense yellow color. Ferrous iron levels below 50 ppm do not interfere, but low levels of ferric iron will cause a large blank. Highly buffered samples may exceed the capacity of the system possibly producing inaccurate results. Samples with high levels of nitrite will eventually develop a pale orange color. Scan the sample immediately to avoid this inteference.

PROCEDURE

1. Press and hold  until colorimeter turns on.
2. Press  to select **TESTING MENU.**
3. Select **ALL TESTS** (or another sequence containing **016 Molybdenum HR**) from TESTING MENU.
4. Scroll to and select **016 Molybdenum HR** from menu.
5. Fill clean tube (0290) to 10 mL line with sample water.
6. Insert tube into chamber, close lid and select **SCAN BLANK**.
7. Remove tube from colorimeter. Use a 1.0 mL pipet (0372) to add 1.0 mL of *Mo Buffer (3997). Cap and mix.
8. Use a second 1.0 mL pipet (0372) to add 1.0 mL of *Molybdenum Oxidizing Reagent (6485). Cap and mix.
9. Use 0.05 g spoon (0696) to add one measure of Molybdenum Indicator Powder (6486). Cap and mix until powder dissolves. Solution will turn yellow if molybdenum is present. Mix the tbe to remove bubbles.
10. Insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
11. Press  to turn colorimeter off or press  to exit to a previous menu or make another menu selection.

NICKEL

DIMETHYLGLYOXIME METHOD • CODE 3663-SC

QUANTITY	CONTENTS	CODE
60 mL	*Hydrochloric Acid, 2.5N	*6251PS-H
30 g	*Ammonium Persulfate Reagent	*6566-G
30 mL	*Silver Nitrate Solution, 0.0141N	*6346WT-G
250 mL	Sodium Citrate, 10%	6253-K
60 mL	*Dimethylglyoxime, 1%	*6254-H
60 mL	*Ammonium Hydroxide, Conc.	*6537-H
3	Pipets, 1.0 mL, plastic	0354
1	Spoon, 0.1 g, plastic	0699
1	Test tube, 5-10-12.9-15-20-25, glass, w/cap	0608
1	Graduated Cylinder, 10 mL, glass	0416

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Nickel is not usually found in natural waters except as a result of contamination from industrial wastewaters as a corrosion product of stainless steel and nickel alloys. Nickel may also enter surface waters from plating bath process water.

APPLICATION:	Drinking and surface waters; domestic and industrial wastewater.
RANGE:	0.00–8.00 ppm Nickel
MDL:	0.15 ppm
METHOD:	Nickel under basic conditions forms a colored complex with dimethylglyoxime in proportion to the concentration of nickel.
SAMPLE HANDLING & PRESERVATION:	Samples may be collected in either plastic or glass containers and preserved by adding 5 mL of concentrated nitric acid per liter.
INTERFERENCES:	Organic matter interferes. Cobalt, iron, copper, manganese and chromium do not interfere if each of the concentrations is below 15 ppm.

PROCEDURE

1. Use the 10 mL graduated cylinder (0416) to measure 10 mL of sample water. Pour into glass test tube (0608).
2. Use the 1 mL pipet (0354) to add 1 mL of *Hydrochloric Acid, 2.5N (6251).
3. Use the 0.1 g spoon (0699) to add 2 measures of *Ammonium Persulfate Reagent (6566). Add two drops of *Silver Nitrate Solution, 0.0141N (6346WT). Mix until the powder has dissolved. The solution will be slightly cloudy at this point.
4. Use 10 mL graduated cylinder (0416) to add 5 mL of Sodium Citrate, 10% (6253).
5. Use a second 1 mL pipet (0354) to add 1 mL of *Ammonium Hydroxide, Conc. (6537). Mix, then dilute to 25 mL with deionized water.
6. Use a third 1 mL pipet (0354) to add 1 mL of *Dimethylglyoxime, 1% (6254). Mix. Wait 20 minutes for color development.
7. At end of 20 minute waiting period fill a clean tube (0290) to the 10 mL line with the developed test sample.
8. Fill a second clean tube (0290) to 10 mL line with deionized water or untreated sample water. This is the blank.
9. Press and hold  until colorimeter turns on.
10. Press  to select **TESTING MENU**.
11. Select **ALL TESTS** (or another sequence containing **017 Nickel**) from **TESTING MENU**.
12. Scroll to and select **017 Nickel** from menu.
13. Insert the blank into chamber, close lid and select **SCAN BLANK**.
14. Insert test sample into chamber, close lid and select **SCAN SAMPLE**. Record result.
15. Press  to turn colorimeter off or press  to exit to a previous menu or make another menu selection.

NOTE: It is strongly suggested that a reagent blank be determined to account for any contribution to the test result by the reagent system. To determine the reagent blank, follow the above test procedure to scan a distilled or deionized water blank. Then follow the above procedure to perform the test on a distilled or deionized water sample. This test result is the reagent blank. Subtract the reagent blank from all subsequent test results of unknown samples.

OZONE

INDIGO METHOD • CODE 365I-SC

QUANTITY	CONTENTS	CODE
15 mL	Chlorine Inhibitor	3990-E
250 mL	*Ozone Buffer	*3991-K
30 mL	Indigo Blue Stock Solution	3989-G
1	Sampling Apparatus	0681
1	Pipet, transfer, 1.0 mL	2-2170
1	Pipet, transfer, 5 mL	0329
1	Pump, 10 mL	30527
1	Bottle, HR Reagent, amber glass	0680-J
1	Graduated Cylinder, 50 mL, glass	0418

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

Ozone is sometimes used in place of, or in conjunction with, chlorine or other halogens for disinfection of pool, spa, or drinking waters. Recently, large aquatic facilities have begun using ozone as a disinfectant in many artificial habitats.

APPLICATION:	Drinking, pool and aquatic waters.
RANGE:	0.00–0.40 ppm Ozone, Low Range 0.00–3.00 ppm Ozone, High Range
MDL:	0.02 ppm Ozone, Low Range 0.05 ppm Ozone, High Range
METHOD:	Ozone rapidly and stoichiometrically decolorizes Indigo Trisulfonate under acidic conditions.
SAMPLE HANDLING & PRESERVATION:	Ozone is extremely unstable in aqueous solutions. Test must be performed immediately and the sample must not be agitated.
INTERFERENCES:	Manganese at any level interferes.

PROCEDURE–LOW RANGE

A. PREPARATION OF HR REAGENT

NOTE: The quantity of Indigo Blue Stock solution (3989) supplied will prepare one batch of HR Reagent for the High Range Ozone procedure or five batches of HR Reagent for the Low Range Ozone procedure.

1. Use the 50 mL graduated cylinder to carefully add 45 mL of *Ozone Buffer (3991) to amber glass bottle marked HR Reagent (0680).
2. Use the 5 mL transfer pipet (0329) and pump (30527) to add 5 mL of Indigo Blue Stock Solution (3989) to the amber glass bottle. Cap and mix.

B. DETERMINATION OF OZONE

3. Use the 1.0 mL transfer pipet (2-2170) and pump (30527) to add 1.0 mL of HR Reagent to each of 2 clean tubes (0290).
4. If chlorine is present add 3 drops Chlorine Inhibitor (3990) to each tube. Cap tubes.
5. Take one of the prepared tubes (0290) and sampling apparatus (0681) to sampling site.
6. Lower end of tubing of sampling apparatus to desired depth. Slowly withdraw and depress plunger several times to purge syringe and tubing. Slowly withdraw plunger to fill purged syringe.
7. Remove plastic tubing from syringe. Remove cap from the prepared tube. Place tip of syringe against inside of the prepared tube. Slowly depress plunger and fill to the 10 mL line and cap. This is the Sample Tube.
   NOTE: DO NOT SHAKE OR INVERT THE SAMPLE.
8. Fill the second prepared tube (0290) to the 10 mL line with ozone free water. This is the Reagent Blank.
9. Press and hold ⏻ until colorimeter turns on.
10. Press ENTER to select **TESTING MENU**.
11. Select **ALL TESTS** (or another sequence containing **018 Ozone LR**) from **TESTING MENU**.
12. Scroll to and select **018 Ozone LR** from menu.
13. Insert the Reagent Blank tube into chamber, close lid and select **SCAN BLANK**.
14. Insert reacted Sample Tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
15. Press ⏻ to turn colorimeter off or press EXIT to exit to a previous menu or make another menu selection.

NOTE: HR Reagent must be made fresh each week. If reagent is refrigerated, it may be kept up to 3 weeks.

PROCEDURE–HIGH RANGE

A. PREPARATION OF HR REAGENT

NOTE: The quantity of Indigo Blue Stock solution (3989) supplied will prepare one batch of HR Reagent for the High Range Ozone procedure or five batches of HR Reagent for the Low Range Ozone procedure.

1. Use the 50 mL graduated cylinder to carefully add 25 mL of *Ozone Buffer (3991) to amber glass bottle marked HR Reagent (0680).
2. Use the 50 mL graduated cylinder to carefully add 25 mL of Indigo Blue Stock Solution (3989) to the amber glass bottle. Cap and mix.

B. DETERMINATION OF OZONE

3. Use the 1.0 mL transfer pipet (2-2170) and pump (30527) to add 1.0 mL of HR Reagent to each of 2 clean tubes (0290).
4. If chlorine is present add 3 drops Chlorine Inhibitor (3990) to each tube. Cap tubes.
5. Take one of the prepared tubes (0290) and sampling apparatus (0681) to sampling site.
6. Lower end of tubing of sampling apparatus to desired depth. Slowly withdraw and depress plunger several times to purge syringe and tubing. Slowly withdraw plunger to fill purged syringe.
7. Remove plastic tubing from syringe. Remove cap from the prepared tube. Place tip of syringe against inside of the prepared tube. Slowly depress plunger and fill to the 10 mL line and cap. This is the Sample Tube.
   NOTE: DO NOT SHAKE OR INVERT THE SAMPLE.
8. Fill the second prepared tube (0290) to the 10 mL line with ozone free water. This is the Reagent Blank.
9. Press and hold ⏻ until colorimeter turns on.
10. Press ENTER to select **TESTING MENU**.
11. Select **ALL TESTS** (or another sequence containing **019 Ozone HR**) from **TESTING MENU**.
12. Scroll to and select **019 Ozone HR** from menu.
13. Insert the Reagent Blank tube into chamber, close lid and select **SCAN BLANK**.
14. Insert reacted Sample Tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
15. Press ⏻ to turn colorimeter off or press EXIT to exit to a previous menu or make another menu selection.

NOTE: HR Reagent must be made fresh each week. If reagent is refrigerated, it may be kept up to 3 weeks.

PHOSPHATE – LOW RANGE

ASCORBIC ACID REDUCTION METHOD
CODE 3653-SC

QUANTITY	CONTENTS	CODE
60 mL	*Phosphate Acid Reagent	*V-6282-H
5 g	*Phosphate Reducing Reagent	*V-6283-C
1	Pipet, 1 mL, plastic	0354
1	Spoon, 0.1 g, plastic	0699

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

Phosphorus is an important nutrient for aquatic plants. The amount found in water is generally not more than 0.1 ppm unless the water has become polluted from waste water sources or excessive drainage from agricultural areas. When phosphorus is present in excess of the concentrations required for normal aquatic plant growth, a process called eutrophication takes place. This creates a favorable environment for the increase in algae and weeds. When algae cells die, oxygen is used in the decomposition and fish kills often result. Rapid decomposition of dense algae scums with associated organisms give rise to foul odors and hydrogen sulfide gas.

APPLICATION:	Drinking, surface and saline waters; domestic and industrial wastes (Method based on reactions that are specific for orthophosphate).
RANGE:	0.00–3.00 ppm Orthophosphate
MDL:	0.05 ppm
METHOD:	Ammonium molybdate and antimony potassium tartrate react in a filtered acid medium with dilute solution of PO_4^{-3} to form an antimony-phosphomolybdate complex. This complex is reduced to an intense blue colored complex by ascorbic acid. The color is proportional to the amount of phosphate present. (Only orthophosphate forms a blue color in this test.) Polyphosphates (and some organic phosphorus compounds) may be converted to the orthophosphate form by sulfuric acid digestion. Organic phosphorus compounds may be converted to the orthophosphate form by persulfate digestion.
SAMPLE HANDLING & PRESERVATION:	If benthic deposits are present in the area being sampled, great care should be taken not to include these deposits. If the analysis cannot be performed the same day of collection, the sample should be preserved by the addition of 2 mL of concentrated sulfuric acid or 40 mg mercuric chloride per liter and refrigerated at 4°C.
INTERFERENCES:	a. No interference from copper, iron, or silicate at concentrations many times the concentration of sea water. However, high iron concentrations can cause precipitation and subsequent loss of phosphorus. b. Salt error for samples ranging from 5% to 20% salt content was found to be less than 1%. c. Mercuric chloride, $HgCl_2$, when used as the preservative, interferes when the chloride levels are low (less than 50 mg/L). This interference is overcome by spiking samples with a minimum of 50 mg/L of sodium chloride.

PROCEDURE

1. Press and hold ⏻ until colorimeter turns on.
2. Press ENTER to select **TESTING MENU**.
3. Select **ALL TESTS** (or another sequence containing **020 Phosphate LR**) from **TESTING MENU**.
4. Scroll to and select **020 Phosphate LR** from menu.
5. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
6. Insert tube into chamber, close lid and select **SCAN BLANK**.
7. Remove tube from colorimeter. Use 1.0 mL pipet (0354) to add 1.0 mL of *Phosphate Acid Reagent (V-6282). Cap and mix.
8. Use the 0.1 g spoon (0699) to add one measure of *Phosphate Reducing Reagent (V-6283). Cap and mx until powder dissolves. Wait 5 minutes for full color development. Solution will turn blue if phosphates are present.
9. At end of 5 minute waiting period, mix, insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
10. Press ⏻ to turn colorimeter off or press EXIT to exit to a previous menu or make another menu selection.

PHOSPHATE – HIGH RANGE

VANADOMOLYBDOPHOSPHORIC ACID METHOD
CODE 3655-SC

QUANTITY	CONTENTS	CODE
4 x 30 mL	*VM Phosphate Reagent	*4410-G
1	Pipet, 1.0 mL, plastic	0354

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

Phosphate treatments in boiler and cooling water and other industrial water systems are run at levels up to 100 ppm orthophosphate. These high levels permit the use of a simpler, high range test.

APPLICATION:	Boiler, cooling, and industrial water.
RANGE:	0.0–70.0 ppm Phosphate
MDL:	0.5 ppm
METHOD:	Orthophosphate reacts in acid conditions with ammonium vanadomolybdate to form vanadomolybdophosphoric acid. This yellow color is proportional to the concentration of orthophosphate and is read colorimetrically.
SAMPLE HANDLING & PRESERVATION:	If the analysis cannot be performed the same day of collection, the sample should be preserved by the addition of 2 mL of concentrated sulfuric acid or 40 mg mercuric chloride per liter and refrigerated at 4°C.
INTERFERENCES:	Silica interferes only if the sample is heated. Arsenate, fluoride, thorium, bismuth, sulfide, thiosulfate, and thiocyanate cause negative interference.

PROCEDURE

1. Press and hold  until colorimeter turns on.
2. Press  to select **TESTING MENU**.
3. Select **ALL TESTS** (or another sequence containing **021 Phosphate HR**) from **TESTING MENU**.
4. Scroll to and select **021 Phosphate HR** from menu.
5. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
6. Insert tube into chamber, close lid and select **SCAN BLANK**.
7. Remove tube from colorimeter. Use the 1.0 mL pipet (0354) to add 2.0 mL of *VM Phosphate Reagent (4410). Cap and mix. Wait 5 minutes for full color development.
8. After 5 minute waiting period, mix, insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
9. Press  to turn colorimeter off or press  to exit to a previous menu or make another menu selection.

POTASSIUM

TETRAPHENYLBORON METHOD • CODE 3639-SC

QUANTITY	CONTENTS	CODE
30 mL	*Sodium Hydroxide, 1.0N	*4004WT-G
5 g	*Tetraphenylboron Powder	*6364-C
1	Spoon, 0.05 g, plastic	0696

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Potassium, as the seventh most common element on the Earth, may be found in minor quantities in most water supplies. It seldom exceeds 10 ppm in drinking water and usually is less than 2 ppm. In some brine or runoff in agricultural areas the potassium concentration may reach 100 ppm.

APPLICATION:	Drinking, surface, and saline water.
RANGE:	0.0–10.0 ppm Potassium
MDL:	0.8 ppm
METHOD:	Potassium reacts with sodium tetraphenylborate to form a colloidal white precipitate in quantities proportional to the potassium concentration.
SAMPLE HANDLING & PRESERVATION:	Store samples in polyethylene bottles, not in soft glass where leaching of potassium from the glass may occur. Samples may be acidified to pH 2 with nitric acid, but should be neutralized before analyzing.
INTERFERENCE:	Calcium and magnesium interfere at very high concentrations. Check for stray light interference (see p. 69).

PROCEDURE

1. Press and hold ⏻ until colorimeter turns on.
2. Press ENTER to select **TESTING MENU**.
3. Select **ALL TESTS** (or another sequence containing **022 Potassium**) from **TESTING MENU**.
4. Scroll to and select **022 Potassium** from menu.
5. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
6. Insert tube into chamber, close lid and select SCAN BLANK.
7. Remove tube from colorimeter. Add 4 drops of *Sodium Hydroxide, 1.0N (4004WT). Cap and mix.
8. Use the 0.05 g spoon (0696) to add one measure of *Tetraphenylboron Powder (6364). Cap and shake vigorously until all of the powder has dissolved. Wait 5 minutes.
9. At end of 5 minute waiting period, mix tube again to suspend any settled precipitate. Insert tube into chamber, close lid and select SCAN SAMPLE. Record result.
10. Press ⏻ to turn colorimeter off or press EXIT to exit to a previous menu or make another menu selection.

NOTES: For best possible results, a reagent blank should be determined to account for any contribution to the test result by the reagent system. To determine the reagent blank, follow the above test procedure to scan a distilled or deionized water blank. Then follow the above procedure to perform the test on a distilled or deionized water sample. This test result is the reagent blank. Subtract the reagent blank from all subsequent test results of unknown samples. It is necessary to determine the reagent blank only when a new lot number of reagents are obtained.

For the most accurate results, the sample and reagents should be at 25±4°C.

SILICA – LOW RANGE

HETEROPOLY BLUE METHOD • CODE 3664-SC

QUANTITY	CONTENTS	CODE
30 mL	*Silica Reagent #1	*V-4466-G
30 mL	*Silica Reagent #2	*V-4467-G
30 mL	*Silica Reagent #3	*V-4468-G
10 g	*Silica Reagent #4	*V-6284-D
1	Spoon, 0.1 g, plastic	0699

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Silicon dioxide, SiO_2, commonly known as silica, occurs in all natural water. Silica may be present as suspended, insoluble particles in a colloidal or polymeric state. It may also be present in a reactive form as silicic acid or silicate ions. Silica is a major nutrient for diatoms. A silica cycle occurs in many bodies of water containing organisms, such as diatoms, that use silica in their skeletal structure. The silica removed from the water may be slowly returned to solution by the decomposition of the dead organisms. The major source of silica in natural water is from the decomposition of silicate minerals in the drainage basin from which the waters flow.

The presence of silica is particularly objectionable in water used for boiler feed water purposes, as it may cause the formation of a hard, dense scale which has unusually high resistance to heat transfer. Serious loss of turbine efficiency results from insoluble silica turbine blade deposits caused by vaporization of silica from boiler water.

APPLICATION:	Drinking, surface and saline waters; domestic and industrial wastes.
RANGE:	0.0–4.0 ppm Silica
MDL:	0.05 ppm
METHOD:	Reactive silica forms a complex with ammonium molybdate in an acidic solution to produce a yellow-green color in proportion to the amount of silica present. Phosphate also reacts with molybdate but the addition of oxalic acid eliminates the molybdophosphoric acid complex. This silica molybdate complex is then reduced by ascorbic acid to produce an intense blue color.
SAMPLE HANDLING & PRESERVATION:	Silica samples may be preserved by refrigeration at 4°C in plastic containers up to one week without any change in silica concentration.
INTERFERENCES:	Sulfides and large amounts of iron interfere. Color and turbidity may be removed by standardizing the instrument with the original water sample. Since silica is a component of glass waste and a common contaminant, it is suggested to run a reagent blank using silica-free water. The blank value is subtracted from the sample concentrations.

PROCEDURE

1. Press and hold ⏻ until colorimeter turns on.
2. Press ENTER to select **TESTING MENU**.
3. Select **ALL TESTS** (or another sequence containing **023 Silica LR**) from **TESTING MENU**.
4. Scroll to and select **023 Silica LR** from menu.
5. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
6. Insert tube into chamber, close lid and select **SCAN BLANK**. (See Note)
7. Remove tube from colorimeter. Add 6 drops *Silica Reagent #1 (V-4466). Cap and invert to mix.
8. Add 12 drops of *Silica Reagent #2 (V-4467). Cap and mix. Wait 5 minutes.
9. Add 8 drops of *Silica Reagent #3 (V-4468). Cap and mix. Wait 2 minutes.
10. Use the 0.1 g spoon (0699) to add one measure of *Silica Reagent #4 (V-6284). Cap and mix gently until powder has dissolved. Wait 5 minutes for full color development.
11. At end of 5 minute waiting period, mix, insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
12. Press ⏻ to turn colorimeter off or press EXIT to exit to a previous menu or make another menu selection.

NOTE: For best possible results, a reagent blank should be determined to account for any contribution to the test result by the reagent system. To determine the reagent blank, follow the above test procedure to scan a distilled or deionized water blank. Then follow the above procedure to perform the test on a distilled or deionized water sample. This test result is the reagent blank. Subtract the reagent blank from all subsequent test results of unknown samples. It is necessary to determine the reagent blank only when a new lot number of reagents are obtained.

SILICA – HIGH RANGE

SILICOMOLYBDATE METHOD • CODE 3687-SC

QUANTITY	CONTENTS	CODE
30 mL	*Silica Reagent #1	*V-4466-G
30 mL	*Silica Reagent #2	*V-4467-G
15 mL	*Silica Reagent #3	*V-4468-G

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

Silicon dioxide, SiO_2, commonly known as silica, occurs in all natural water. Silica may be present as suspended, insoluble particles in a colloidal or polymeric state. It may also be present in a reactive form as silicic acid or silicate ions. Silica is a major nutrient for diatoms. A silica cycle occurs in many bodies of water containing organisms, such as diatoms, that use silica in their skeletal structure. The silica removed from the water may be slowly returned to solution by the decomposition of the dead organisms. The major source of silica in natural water is from the decomposition of silicate minerals in the drainage basin from which the waters flow.

The presence of silica is particularly objectionable in water used for boiler feed water purposes, as it may cause the formation of a hard, dense scale which has unusually high resistance to heat transfer. Serious loss of turbine efficiency results from insoluble silica turbine blade deposits caused by vaporization of silica from boiler water.

APPLICATION:	Boilers and cooling towers; domestic and industrial wastes.
RANGE:	0–75 ppm Silica
MDL:	0.5 ppm
METHOD:	Silica forms a complex with ammonium molybdate in an acidic solution to produce a yellow color in proportion to the amount of silica present. Phosphate also reacts with molybdate but the addition of oxalic acid eliminates the molybdophosphoric acid complex.
SAMPLE HANDLING & PRESERVATION:	Silica samples may be preserved by refrigeration at 4°C in plastic containers up to one week without any change in silica concentration.
INTERFERENCES:	Sulfides and large amounts of iron interfere. Color and turbidity may be removed by standardizing the instrument with the original water sample.

PROCEDURE

1. Press and hold  until colorimeter turns on.
2. Press  to select **TESTING MENU**.
3. Select **ALL TESTS** (or another sequence containing **024 Silica HR**) from **TESTING MENU**.
4. Scroll to and select **024 Silica HR** from menu.
5. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
6. Insert tube into chamber, close lid and select **SCAN BLANK**.
7. Remove tube from colorimeter. Add 6 drops *Silica Reagent #1 (V-4466). Cap and invert to mix.
8. Add 12 drops of *Silica Reagent #2 (V-4467). Cap and mix. Wait 5 minutes.
9. At end of 5 minute waiting period, add 8 drops of *Silica Reagent #3 (V-4468). Cap and mix.
10. Insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
11. Press  to turn colorimeter off or press  to exit to a previous menu or make another menu selection.

NOTE: To extend the range to 100 ppm, perform a 2:1 dilution of water sample, with silica-free water. Perform test and multiply result by 2.

SULFATE – HIGH RANGE

BARIUM CHLORIDE METHOD • CODE 3665-SC

QUANTITY	CONTENTS	CODE
10 g	*Sulfate Reagent	*V-6277-D
1	Spoon, 0.1 g, plastic	0699

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

The most common mineral forms of sulfur are iron sulfide, lead sulfide, zinc sulfide and as calcium sulfate and magnesium sulfate. In most fresh waters the sulfate ion is the second or third most abundant anion, being exceeded only by bicarbonate and, in some cases, silicate. Sulfur, in the form of sulfate, is considered an important nutrient element. Mineral springs are rich in sulfate and feed appreciable quantities of this compound to the watershed. Acid mine water drainage is a form of pollution which may contribute extremely large amounts of sulfate content to natural waters. Other sources of sulfate include waste material from pulp mills, steel mills, food processing operations and municipal wastes. Many bacteria obtain sulfur from sulfate for the synthesis of amino acids. In lakes and streams low in oxygen, this process of sulfate reduction causes the production of hydrogen sulfide, with its characteristic offensive odor. Calcium sulfate and magnesium sulfate contribute significantly to the hardness of water. Under natural conditions, the quantities ordinarily to be expected in lakes are between 3 and 30 parts per million.

APPLICATION:	Drinking and surface waters, domestic and industrial wastes.
RANGE:	0–100 ppm Sulfate
MDL:	3 ppm
METHOD:	Sulfate ion is precipitated in an acid medium with barium chloride to form a barium sulfate suspension in proportion to the amount of sulfate present.
SAMPLE HANDLING & PRESERVATION:	Sulfate samples may be preserved by refrigeration at 4°C up to 7 days in glass or plastic containers without any change in concentration.
INTERFERENCE:	Suspended matter and color interference may be removed by a filtration step. Silica in excess of 500 mg/L will interfere. Check for stray light interference (see page 69).

PROCEDURE

1. Press and hold  until colorimeter turns on.
2. Press ENTER to select **TESTING MENU**.
3. Select **ALL TESTS** (or another sequence containing **025 Sulfate HR**) from **TESTING MENU**.
4. Scroll to and select **025 Sulfate HR** from menu.
5. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
6. Insert tube into chamber, close lid and select **SCAN BLANK**.
7. Remove tube from colorimeter. Use the 0.1 g spoon (0699) to add one measure of *Sulfate Reagent (V-6277). Cap and shake until powder dissolves. A white precipitate will develop if sulfates are present. Wait 5 minutes.
8. Mix tube again. Insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
9. Press  to turn colorimeter off or press EXIT to exit to a previous menu or make another menu selection.

NOTE: If the sulfate concentration of the test sample is greater than 100 ppm, it is recommended that a dilution be made with deionized water and the results multiplied by the dilution factor.

A white film is deposited on the inside of test tubes as a result of the sulfate test. Thoroughly clean and rinse test tubes after each test.

For the most accurate results, samples and reactions should be at 25±4°C.

SULFIDE – LOW RANGE

METHYLENE BLUE METHOD • CODE 3654-02-SC

QUANTITY	CONTENTS	CODE
2 x 30	*Sulfide Reagent A	*V-4458-G
15 mL	*Sulfide Reagent B	*V-4459-E
2 x 60 mL	Sulfide Reagent C	4460-H
2	Pipets, 1.0 mL, plastic	0354

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

Sulfide occurs in many well water supplies and sometimes is formed in lakes or surface waters. In distribution systems, it may be formed as a result of bacterial action on organic matter under anaerobic conditions. It may also be found in waters receiving sewage or industrial wastes. Lake muds rich in sulfates produce hydrogen sulfide during periods of very low oxygen levels that result from stagnation. Concentrations of a few hundredths of a part per million (or milligram per liter) cause a noticeable odor. At low concentrations, this odor is described as “musty”; at high concentration, as “rotten eggs.” Removal of sulfide odor is accomplished by aeration or chlorination. Hydrogen sulfide, a toxic substance, acts as a respiratory depressant in both humans and fish.

APPLICATION:	Drinking, surface and saline waters; domestic and industrial wastes.
RANGE:	0.00–1.50 ppm Sulfide
MDL:	0.06 ppm
METHOD:	Under suitable conditions the sulfide ion reacts with p-aminodimethylaniline and ferric chloride to produce methylene blue in proportion to the sulfide concentration. Ammonium phosphate is added to remove the color due to the ferric iron.
SAMPLE HANDLING & PRESERVATION:	Samples must be taken with a minimum of aeration since sulfide is volatilized by aeration and any oxygen which is taken up will destroy sulfides by chemical action. Samples that are used for total sulfide concentrations may be preserved by adding 2M zinc acetate solution at a dosage of 2 mL per liter of sample. This precipitates sulfide as inert zinc sulfide. Determination of dissolved sulfides in samples not preserved with zinc acetate must be started within 3 minutes of sampling.
INTERFERENCES:	Strong reducing agents such as sulfite, thiosulfate, and hydrosulfite prevent the formation of the color or diminish its intensity. High concentrations of sulfide will inhibit the reaction, but dilution of the sample prior to analysis eliminates this problem.

PROCEDURE

1. Press and hold ⏻ until colorimeter turns on.
2. Press ENTER to select **TESTING MENU**.
3. Select **ALL TESTS** (or another sequence containing **026 Sulfide LR**) from **TESTING MENU**.
4. Scroll to and select **026 Sulfide LR** from menu.
5. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
6. Insert tube into chamber, close lid and select **SCAN BLANK**.
7. Remove tube from colorimeter. Use the 1.0 mL pipet (0354) to add 1.0 mL of *Sulfide Reagent A (V-4458). Cap and mix.
8. Add 6 drops of Sulfide Reagent B (V-4459). Cap and mix. Wait 1 minute. Solution will turn blue if sulfides are present.
9. Use the 1.0 mL pipet (0354) to add 2.0 mL of Sulfide Reagent C (4460). Cap and mix. Color development is immediate and stable.
10. Insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
11. Press ⏻ to turn colorimeter off or press EXIT to exit to a previous menu or make another menu selection.

TANNIN

TUNGSTO-MOLYBDOPHOSPHORIC ACID METHOD CODE 3666-01-SC

QUANTITY	CONTENTS	CODE
30 mL	*Tannin Reagent #1	*7833-G
2 x 60 mL	*Tannin Reagent #2	*7834-H
1	Pipet, plain, plastic	0352
1	Pipet, 1.0 mL, plastic	0354

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

Tannin and lignin are examples of hydroxylated aromatic compounds found in discharge wastewater from paper mills, in some boiler water treatment, in natural brackish water, and in wastewater from leather tanning plants. The taste and odor of these compounds is generally offensive so that their control is important in many areas.

APPLICATION:	Industrial wastewater, boiler water, and natural water.
RANGE:	0.0–10.0 ppm Tannic Acid
MDL:	0.1 ppm
METHOD:	The hydroxylated aromatic compounds will reduce a mixture of tungstophosphoric and molybdophosphoric acids to form a blue color in proportion to the concentration of aromatic hydroxyl groups.
SAMPLE HANDLING & PRESERVATION:	Sample should be analyzed as soon as possible after collection.
INTERFERENCES:	Other reducing compounds such as ferrous iron and sulfites. Results may be expressed as tannin like compounds, or aromatic hydroxy compounds.

PROCEDURE

1. Press and hold ⏻ until colorimeter turns on.
2. Press ENTER to select **TESTING MENU**.
3. Select **ALL TESTS** (or another sequence containing **027 Tannin**) from **TESTING MENU**.
4. Scroll to and select **027 Tannin** from menu.
5. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
6. Insert tube into chamber, close lid and select **SCAN BLANK**.
7. Remove tube from colorimeter. Use the plain pipet (0352) to add 4 drops of *Tannin Reagent #1 (7833). Cap and mix.
8. Use the 1.0 mL pipet (0354) to add 2.0 mL of *Tannin Reagent #2 (7834). Cap and mix. Wait 30 minutes for full color development.
9. At end of 30 minute waiting period, mix, insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
10. Press ⏻ to turn colorimeter off or press EXIT to exit to a previous menu or make another menu selection.

NOTES: For best possible results, a reagent blank should be determined to account for any contribution to the test result by the reagent system. To determine the reagent blank, follow the above test procedure to scan a distilled or deionized water blank. Then follow the above procedure to perform the test on a distilled or deionized water sample. This test result is the reagent blank. Subtract the reagent blank from all subsequent test results of unknown samples. It is necessary to determine the reagent blank only when a new lot number of reagents is obtained.

For the most accurate results, the sample and reagents should be at 20 ±2°C.

TURBIDITY

ABSORPTION METHOD • NO REAGENTS REQUIRED

Turbidity is a measure of water clarity and is independent of color. Turbidity is caused by undissolved and suspended solids. Mud, silt, algae, and microorganisms can all cause turbidity. Turbidity is a gross measurement of water quality.

APPLICATION:	Surface and industrial water for non-compliance monitoring. (For compliance monitoring at low turbidity levels, use a commercial nephelometer.)
RANGE:	0–500 FAU (Formazon Attenuation Units)
MDL:	3 FAU
METHOD:	Absorptimetric, 180° detector
SAMPLE HANDLING & PRESERVATION:	Measure sample as soon as possible after collection.
INTERFERENCES:	Check for stray light interference (see page 69).

PROCEDURE

1. Press and hold ⏻ until colorimeter turns on.
2. Press ENTER to select **TESTING MENU**.
3. Select **ALL TESTS** (or another sequence containing **028 Turbidity**) from **TESTING MENU**.
4. Scroll to and select **028 Turbidity** from menu.
5. Rinse a clean tube (0290) with deionized water (turbidity free). Fill to the 10 mL line with deionized water.
6. Insert tube into chamber, close lid and select **SCAN BLANK**.
7. Rinse a second clean tube (0290) with sample water. Fill to the 10 mL line with sample. Cap tube. Wipe off excess water and fingerprints. Shake to resuspend particulate matter. Remove all bubbles before measurement.
8. Insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result. Turbidity measurements should be taken as soon as possible after sample has been collected.
9. Press ⏻ to turn colorimeter off or press EXIT to exit to a previous menu or make another menu selection.

NOTE: For the most accurate results, the sample should be at 25±4°C.

PREPARING FORMAZIN SOLUTIONS

The turbidity calibration was prepared by using standard formazin solutions as a reference. These solutions can be prepared by carefully following the procedure below.†

1. Dissolve 1.000 g of Hydrazine Sulfate in deionized water and dilute to mark in 100 mL volumetric flask.
2. Dissolve 10.00 g of Hexamethylenetetramine in deionized water and dilute to mark in 100 mL volumetric flask.
3. Mix 5 mL of each solution in a 100 mL volumetric flask and allow to set undisturbed for 24 hours.
4. At the end of the waiting period, dilute to mark with deionized water and mix.
5. The turbidity of the stock solution is 400 FTU. The stock solution is stable for one month. Dilutions from the stock should be prepared fresh daily.

†Alternatively, a prepared concentrated formazin standard of 4000 NTU may be ordered in a 60 mL size by Code 6195-H.

ZINC – LOW RANGE

ZINCON METHOD • CODE 3667-SC

QUANTITY	CONTENTS	CODE
30 mL	*Zinc Indicator Solution	*6314-G
120 mL	*Methyl Alcohol	*6319-J
10 g	Sodium Ascorbate Powder	6316-D
25 g	*Zinc Buffer Powder	*6315-G
15 mL	*Sodium Cyanide, 10%	*6565-E
30 mL	*Formaldehyde Solution, 37%	*5128-G
1	“Dilute Zinc Indicator Solution” Bottle, w/1 pipet assembly	0128-MT
1	Graduated Cylinder, 10 mL, glass	0416
1	Spoon, 0.5 g, plastic	0698
2	Pipets, plain, plastic	0352
1	Spoon, 0.1 g, plastic	0699

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

Zinc enters the domestic water supply from the deterioration of galvanized iron and brass pipes, and from industrial wastes. Zinc is an essential element for body growth and development and is an important plant nutrient. Concentrations of zinc above 5.0 mg/L in drinking water can cause a bitter astringent taste. In the U.S., zinc concentrations may vary between 0.06 to 7.0 mg/L, with an average value of 1.33 mg/L.

APPLICATION: Drinking and surface waters, domestic and industrial waste water.

RANGE: 0.00–3.00 ppm Zinc

MDL: 0.05 ppm

METHOD: Zinc forms a blue colored complex with Zincon in a solution buffered at pH 9.0. Other heavy metals are complexed by cyanide and the zinc cyanide complex is released by the addition of formaldehyde before the other metal cyanide complexes are destroyed. Sodium ascorbate is added to reduce the interference of manganese.

SAMPLE HANDLING & PRESERVATION: Sample should be analyzed within 6 hours after collection. The addition of hydrochloric acid will help preserve the metal ion content, however the acid should be neutralized before analysis.

INTERFERENCES: The following ions interfere in concentrations greater than those listed.

Ion	mg/L	Ion	mg/L
Cd(II)	1	Cr(III)	10
Al (III)	5	Ni(II)	20
Mn (II)	5	Co (II)	30
Fe (III)	7	CrO4(II)	50
Fe (II)	9		

PROCEDURE

A. PREPARATION OF DILUTE ZINC INDICATOR SOLUTION

1. Use a pipet (0352) to measure exactly 5.0 mL of *Zinc Indicator Solution (6314) into 10 mL graduated cylinder (0416). The bottom of the curved surface (the meniscus) of liquid should be at 5.0 mL mark. Pour this into the bottle labeled “Dilute Zinc Indicator Solution”.
2. Use unrinsed graduated cylinder to add 10.0 mL and then 7.8 mL (total of 17.8 mL) of *Methyl Alcohol (6319) to bottle labeled “Dilute Zinc Indicator Solution”. Cap and mix ingredients in this bottle. Do not leave this bottle uncapped.

B. DETERMINATION OF ZINC

1. Press and hold ⏻ until colorimeter turns on.
2. Press ENTER to select **TESTING MENU**.
3. Select **ALL TESTS** (or another sequence containing **029 Zinc LR**) from **TESTING MENU**.
4. Scroll to and select **029 Zinc LR** from menu.
5. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
6. Insert tube into chamber, close lid and select **SCAN BLANK**. (See Note)
7. Remove tube from colorimeter. Use 0.1 g spoon (0699) to add one measure of Sodium Ascorbate Powder (6316). Use 0.5 g spoon (0698) to add one measure of *Zinc Buffer Powder (6315). Cap and shake vigorously for 1 minute. Some undissolved buffer may remain in the bottom of the tube.
8. Add 3 drops of *Sodium Cyanide, 10% (6565). Cap and mix.
9. Use the 1 mL pipet assembly to add 1 mL of “Dilute Zinc Indicator Solution”. Cap and mix.
10. Use a second plain pipet (0352) to add 4 drops of *Formaldehyde Solution, 37% (5128). Cap and mix by inverting 15 times.
11. Insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
12. Press ⏻ to turn colorimeter off or press EXIT to exit to a previous menu or make another menu selection.

NOTE: For best possible results, a reagent blank should be determined to account for any contribution to the test result by the reagent system. To determine the reagent blank, follow the above test procedure to scan a distilled or deionized water blank. Then follow the above procedure to perform the test on a distilled or deionized water sample. This test result is the reagent blank. Subtract the reagent blank from all subsequent test results of unknown samples. It is necessary to determine the reagent blank only when a new lot number of reagents is obtained.

APPENDIX

Ammonia in water occurs in two forms: toxic unionized ammonia (NH_3) and the relatively non-toxic ionized form, ammonium ion (NH_4^+). This test method measures both forms as ammonia-nitrogen (NH_{3+}–N) to give the total ammonia-nitrogen concentration in water. The actual proportion of each compound depends on temperature, salinity, and pH. A greater concentration of unionized ammonia is present when the pH value and salinity increase.

1. Consult the table below to find the percentage that corresponds to the temperature, pH, and salinity of the sample.
2. To express the test result as ppm Unionized Ammonia Nitrogen (NH_3–N), multiply the total ammonia-nitrogen test result by the percentage from the table.
3. To express the test result as ppm Ammonia Nitrogen (NH_{3+}–N), subtract the unionized ammonia-nitrogen determined in step 2 from the total ammonia-nitrogen.

	10°C		15°C		20°C		25°C	
pH	FW1	SW2	FW	SW	FW	SW	FW	SW
7.0	0.19	—	0.27	—	0.40	—	0.55	—
7.1	0.23	—	0.34	—	0.50	—	0.70	—
7.2	0.29	—	0.43	—	0.63	—	0.88	—
7.3	0.37	—	0.54	—	0.79	—	1.10	—
7.4	0.47	—	0.68	—	0.99	—	1.38	—
7.5	0.59	0.459	0.85	0.665	1.24	0.963	1.73	1.39
7.6	0.74	0.577	1.07	0.836	1.56	1.21	2.17	1.75
7.7	0.92	0.726	1.35	1.05	1.96	1.52	2.72	2.19
7.8	1.16	0.912	1.69	1.32	2.45	1.90	3.39	2.74
7.9	1.46	1.15	2.12	1.66	3.06	2.39	4.24	3.43
8.0	1.83	1.44	2.65	2.07	3.83	2.98	5.28	4.28
8.1	2.29	1.80	3.32	2.60	4.77	3.73	6.55	5.32
8.2	2.86	2.26	4.14	3.25	5.94	4.65	8.11	6.61
8.3	3.58	2.83	5.16	4.06	7.36	5.78	10.00	8.18
8.4	4.46	3.54	6.41	5.05	9.09	7.17	12.27	10.10
8.5	5.55	4.41	7.98	6.28	11.18	8.87	14.97	12.40

[1] Freshwater data from Trussel (1972).
[2] Seawater values from Bower and Bidwell (1978).
Salinity for Seawater values = 34% at an ionic strength of 0.701m.

FOR EXAMPLE:

If a fresh water sample at 20°C has a pH of 8.5 and the test result is 1.0 ppm as Total Ammonia-Nitrogen:

1. The percentage from the table is 11.18% (or 0.1118).
2. 1 ppm Total Ammonia-Nitrogen x 0.1118 = 0.1118 ppm Unionized Ammonia-Nitrogen.
3.

Total Ammonia-Nitrogen		1.0000 ppm
Unionized Ammonia-Nitrogen	-	0.1118 ppm
Ionized Ammonia-Nitrogen	=	0.8882 ppm