



**OPERATOR'S
MANUAL**
CODE 1922/1922-EX2



TABLE OF CONTENTS

GENERAL INFORMATION

Packaging & Delivery	5
General Precautions	5
Safety Precautions	5
Limits of Liability	5
Specifications	6
Contents and Accessories	7
EPA Compliance	7
CE Compliance	8

CHEMICAL TESTING

Water Sampling for Chemical Analysis	9
Filtration	10
An Introduction to Colorimetric Analysis	11
Reagent Blank	12
Colorimeter Tubes	12
Selecting an Appropriate Wavelength	12
Calibration Curves	13
Standard Additions	15
Sample Dilution Techniques & Volumetric Measurements	16
Interferences	17
Stray Light Interference	17

OPERATION OF THE COD PLUS COLORIMETER

Overview	18
Power Source	18
Components	19
Quick Start	20

GENERAL OPERATING PROCEDURES

The Keypad	22
Sample Holders	22
The Display & the Menu	23
Looping Menus	25

TESTING

Testing Menu	26
Sequences of Tests	27
General Testing Procedures	28
Testing With the LaMotte Pre-Programmed Tests	28
Calibrating With the LaMotte Pre-Programmed Tests	30
Measuring in the %T/ABS Mode	32

TABLE OF CONTENTS (cont.)

EDITING MENU

Edit a Sequence	34
Adding or Deleting Tests	35
Edit User Tests	38
Naming the Test	39
Selecting the Vial and Wavelength	41
Entering a New Calibration	42
Selecting the Numerical Format of the Result	44
Selecting Units of Concentration.....	45
Setting the Clock.....	46
Turning the Data Logger On and Off	47
Factory Setup	48
Setting the Power Saver Function.....	48

PC LINK

Output	49
Computer Connection	49

BATTERY OPERATION

Replacing the Battery.....	49
----------------------------	----

MAINTENANCE

Cleaning	50
----------------	----

TROUBLESHOOTING GUIDE

Error Messages	50
Helpful Hints	50

SMART REAGENT SYSTEMS

.....	51
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COD PLUS COLORIMETER TEST INSTRUCTIONS

APPENDIX

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 suitable container with adequate packing material. A return authorization number must be obtained from LaMotte Company by calling 1-800-344-3100. 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 COD 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) are supplied for these reagents. Read the accompanying MSDS before using these reagents.

Additional information for all LaMotte reagents is available in the United States from the Poison Control Center listed in the front of the phone book or by calling 1-800-222-1222. Call 1-813-248-0585 to contact the International Poison control Center. LaMotte reagents are registered with a computerized poison control information system available to all local poison control centers. Be prepared to supply the name and four-digit LaMotte code number found on the container label, listed in the test procedures, or at the top of the MSDS.

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

Protect Yourself and Equipment: Use Proper Analytical Techniques

■ 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.

■ SPECIFICATIONS

■ INSTRUMENT TYPE: Colorimeter

Readout	Graphical 4 line, 16 character per line LCD
Wavelengths	430nm, 620 nm
Wavelength Accuracy	± 2 nm
Readable Resolution	Determined by reagent system
Wavelength Bandwidth	10 nm typical
Photometric Range	-2 to +2A
Photometric Precision	± 0.001A
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 with integrated interference filters
Modes	Absorbance, pre-programmed tests
Pre-Programmed Tests	YES, with automatic wavelength selection
User Defined Tests	Up to 10 user tests can be input
RS232 Port	8 pin mini-DIN, 9600b, 8, 1, n
Power Requirements	Battery Operation: 9 volt alkaline Line Operation: 110/220V AC; 50/60 Hz with adapter, 6V 500 mA DC
Dimensions (LxWxH)	8.5 x 16.2 x 16.7 cm, 3.4 x 6.4 x 2.6 inches
Weight	312 g, 11 oz (meter only)
Data Logger	350 test results stored for download to a PC

■ CONTENTS AND ACCESSORIES

■ CONTENTS

- COD PLUS Colorimeter
- Test Tubes, with Caps (4)
- COD Adapter
- Power Supply, 110V or 220V
- COD PLUS Colorimeter Manual

■ ACCESSORIES

- | | |
|--|------------------|
| COD Reactor, 8 Vial Capacity, 110V | Code 5-0069 |
| COD Reactor, 8 Vial Capacity, 220V | Code 5-0070 |
| COD Reactor, 25 Vial Capacity, 110/220V | Code 5-0094 |
| COD Safety Shield for 8 Vial Reactor | Code 5-0071 |
| Small Field Carrying Case | Code 1919-GCS150 |
| Large Field Carrying Case | Code 1919-BCS440 |
| SMARTLink 2 Program & Interface Cable (3.5 disk) | Code 1912-3 |
| SMARTLink 2 Program & Interface Cable (CD) | Code 1912-CD |

■ EPA COMPLIANCE

The COD 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 COD PLUS Colorimeter has earned the European CE Mark of Compliance for electromagnetic compatibility and safety.

DECLARATION OF CONFORMITY

**Standards to which
Conformity Declared:**

EN61326:1998, IEC61326:1997,
IEC61000-4-2:1995, IEC61000-4-3:1995
IEC61000-4-4:1995, IEC61000-4-5:1995
IEC61000-4-6:1996, IEC61000-4-11:1994,
EN61000-3-2:1995, EN61000-3-3:1994-12,
EN55011/CISPR11, FCCCFR47 Part 15,
EN61558

Manufacturer's Name:

LaMotte Company

Manufacturer's Address:

802 Washington Avenue
PO Box 329
Chestertown, MD 21620

Type of Equipment:

Colorimeter

Model Name:

COD Plus

Year of Manufacture:

2001

Testing Performed By:

Windermere
2000 Windermere Court
Annapolis, MD 21401

*I, the undersigned, hereby declare that the equipment specified above
conforms to the above Directive and Standards.*

Chestertown, Maryland

Place

1/15/02

Date



Signature

Scott H. Steffen

Name

VP New Products & Quality

Position

CHEMICAL TESTING

■ 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. 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 COD PLUS Colorimeter can be used to measure a test substance that is itself yellow or green to blue, or can be reacted to produce these colors. 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 COD PLUS Colorimeter passes one of two colored light beams through one of two optical filters which transmits only one particular color or band of wavelengths of light to the photodetector 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 concentration in the sample (the greater the nitrate 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 10 mL of demineralized water. Use sample water to **SCAN BLANK**. Insert the 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

Colorimeter tubes 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**.

■ 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	430
Pink	520
Red	570
Green and Blue	620

NOTE: Available wavelengths in the COD PLUS are 430 nm and 620 nm only.

■ CALIBRATION CURVES

The COD PLUS Colorimeter contains precalibrated tests for the LaMotte reagent systems (p. 49). The first step in using a non-LaMotte reagent system with your COD 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 COD 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 COD PLUS Colorimeter (see EDIT USER TESTS, p. 36).

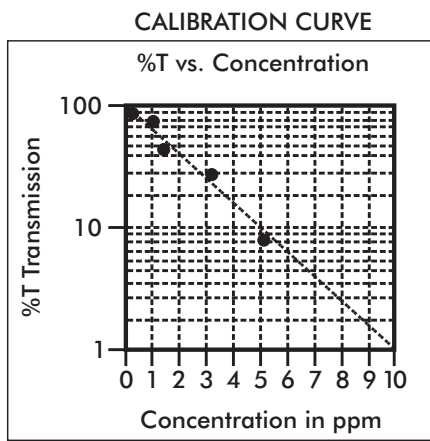
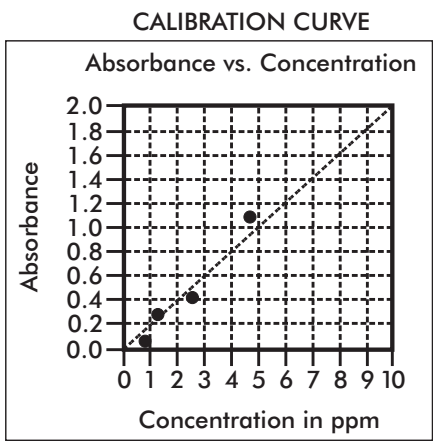
■ PROCEDURE

1. 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.
2. Turn on the COD 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.
3. Use the unreacted 0 ppm standard to standardize the colorimeter by using it to scan blank.
4. 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).

5. 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.
6. 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. ($C = A \times \frac{\%}{100}$).
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 ($C \times \frac{\%}{E} = F$).

A sample chart appears below:

A	B	$C = A \times \frac{\%}{100}$	D	E	$F = C \times \frac{\%}{E}$
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 $(0.10 \text{ mL} \times 50 \text{ ppm})/10.0 \text{ mL} = 0.50 \text{ ppm}$. The concentration of iron determined in the spiked sample should be $0.3 + 0.5 = 0.8 \text{ ppm}$ 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 COD PLUS Colorimeter gives an **OVERRANGE** message then the sample concentration could be over range or under range. If it is over range, the sample must be diluted. Then 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 (p. 16).

■ 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 COD PLUS COLORIMETER

■ OVERVIEW

The COD PLUS Colorimeter is a portable, microprocessor controlled, direct reading colorimeter. It has a graphical 4 line, 16 character liquid crystal display for graphical, alphabetical and numerical messages. The operation is controlled with the keypad through menu driven software in response to selections shown on the display.

The test library consists of 29 LaMotte tests and 10 "User Tests". The LaMotte tests are precalibrated for LaMotte reagent systems. The colorimeter displays the results of these tests directly in units of concentration. The 10 "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 photodiode with an integrated interference filter. The interference filters select a narrow band of light from the corresponding LED for the colorimetric measurements. The microprocessor automatically selects the correct LED/photodiode combination for a test.

A RS-232 serial port on the back of the colorimeter, and optional software, allows the COD PLUS to be interfaced with an IBM compatible personal computer for real time data acquisition and data storage. This port also allows an interface with a RS-232 serial printer.

Due to its portability, alternate power sources, and rugged construction, the COD PLUS Colorimeter is ideal for lab and field use.

■ POWER SOURCE

The COD PLUS Colorimeter uses a 6V 500 mA AC adapter. Please refer to the Parts List for the code number for the correct adapter.

USE OF ANY AC ADAPTER OTHER THAN THE ONE SPECIFIED FOR USE WITH THE COD PLUS COLORIMETER MAY DAMAGE THE METER AND WILL VOID THE WARRANTY.

To use the adapter, slide the connector pin from the AC adapter into the small hole on the left side of the meter. Plug the AC adapter into an appropriate wall socket or power source.

■ COMPONENTS

Figure 1 shows a diagram of the COD PLUS Colorimeter and its components.

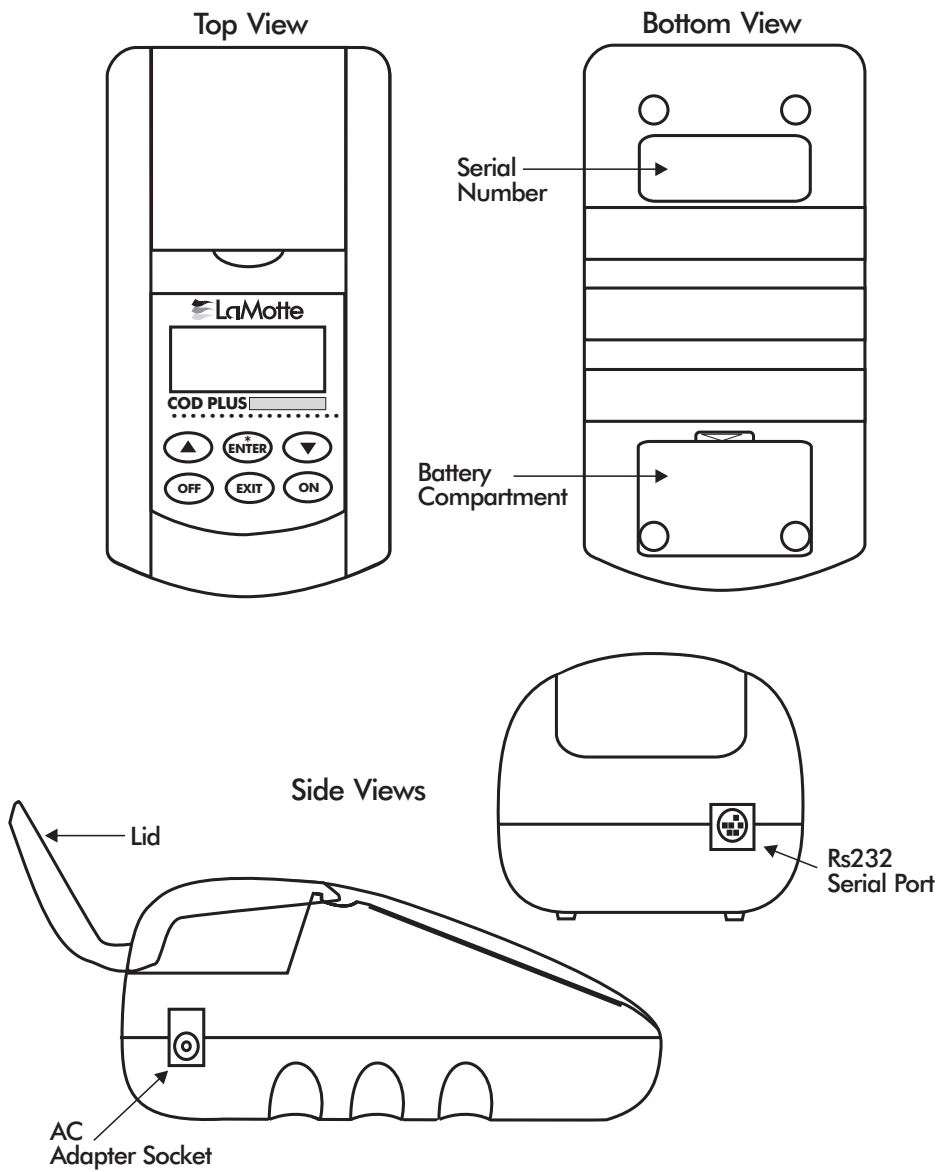


Figure 1

■ QUICK START

Some quick instructions to get into testing.

1. Press **ON** to turn on the COD PLUS. The LaMotte logo screen will appear for about 2 seconds and then the Start screen appears. Press ***/ENTER** to start testing.

VER 1.0
COD PLUS
* Start

2. The Main Menu will appear. Press ***/ENTER** to select TESTING MENU.

MAIN MENU
*Testing Menu
Editing Menu
PC Link

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

TESTING MENU
*All Tests
Sequence 1
Sequence 2

4. Press ▼ or ▲ to move the * to the desired test.

ALL TESTS
*001 COD LR
002 COD SR
003 COD HR

5. Press ***/ENTER** to select test.

ALL TESTS
*002 COD SR
003 COD HR
004 Ammonia-N LF

6. Insert blank, press ***/ENTER** to scan blank.

002 COD SR
* Scan Blank

7. The screen will display Blank Done for about 1 second.

002 COD SR
Blank Done
* Scan Blank

8. Insert the reacted sample. Press ***/ENTER** to scan sample. The COD PLUS will scan the sample and display the concentration.

002 COD SR
* Scan Sample

9. After recording test result, scroll with ▼ or ▲ and make another selection with ***/ENTER**. Press **EXIT** to escape to previous menus.

002 COD SR
722 mgL
* Scan Sample

GENERAL OPERATING PROCEDURES

The operation of the COD 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 PC Link.

■ THE KEYPAD

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

ON	This button is used to turn the colorimeter on.
▼	This button will cause the display to scroll down through a list of menu choices. It will move through a list viewed in the display. It will auto scroll when held down.
▲	This button will cause the display to scroll up in a list of menu choices. It will move through a list viewed in the display. It will auto scroll when held down.
ENTER *	This button is used to select the menu choice adjacent to the “*” in a menu viewed in the display.
EXIT	This button is an exit or escape button. When pressed, the display will exit from the current menu and go to the previous menu.
OFF	This button turns the colorimeter off.

■ SAMPLE HOLDERS

The sample chamber is designed for 25 mm round tubes, and a sample holder for 16 mm COD tubes is included. A 1 cm square UDV cuvette sample holder is available for the COD PLUS Colorimeter.

Position the COD adapter in the SMART 2 chamber so that the grooves in the adapter are aligned with the ridges located at the rear of the chamber. The adapter should be inserted with the small hole, containing the ball plunger, at the top. The ball plunger can be adjusted with a small screwdriver to control the tightness of the fit of the tube in the adapter.

■ THE DISPLAY & THE MENUS

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

There are four lines in the display. The top line in each menu is a title or pertinent instruction. The top line does not change unless a new menu is selected. The second and third lines are used in two ways. One way is to display menu choices. The second way takes advantage of the graphical capabilities of the display. Both lines are used to display important messages, such as test results, in a large, easy to read format. The fourth line is used for menu choices.

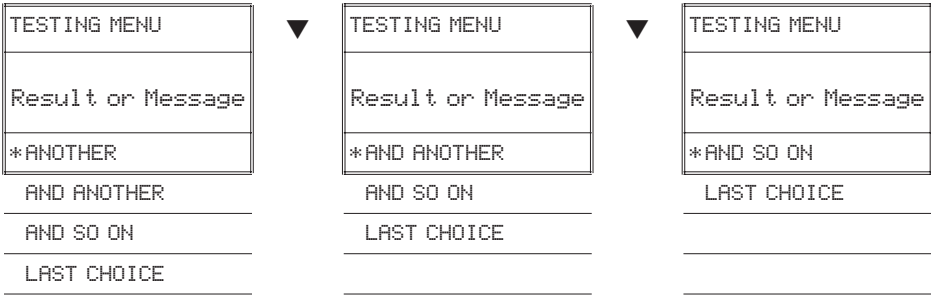
DISPLAY	TESTING MENU	TITLE or INSTRUCTION
	*FIRST CHOICE	MENU CHOICE WINDOW
	SECOND CHOICE	
	ANOTHER	
	AND ANOTHER	
AND SO ON		

Think of the menu choices as a vertical list in the display which moves up or down each time an arrow button is pressed. This list or menu is viewed through a window, the menu choice window, in the display. The menu choice window is the lower 2 or 3 lines of the display. Pushing the arrow buttons brings another portion of the menu into menu choice window. This is referred to as scrolling through the menu.

TESTING MENU	▼	TESTING MENU	▼	TESTING MENU
*FIRST CHOICE		SECOND CHOICE		ANOTHER
SECOND CHOICE		*ANOTHER		AND ANOTHER
ANOTHER		AND ANOTHER		*AND SO ON
AND ANOTHER		AND SO ON		LAST CHOICE
AND SO ON		LAST CHOICE		
LAST CHOICE				

An asterisk, “*”, will start in the far left position of the top line in the menu choice window. As the menu is scrolled through, different choices appear next to the “*”. The “*” in the display corresponds with the ***/ENTER** button. Pushing the ***/ENTER** button selects the menu choice which is adjacent to the “*” in the menu choice window.

The second general format of the display takes advantage of the graphics capabilities of the display. The top line of the display is still a title line. The middle two lines of the display are used to display important messages, results or graphics in a large, easy to read format. The menus work in the same way as described previously but only one line of the menu is 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 **OFF** at any time will turn the colorimeter off.

■ LOOPING MENUS

Long menus, such as All Tests, incorporate a looping feature which allow 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** test at two wavelengths. Testing from any of three sequences can also be done.

1. Press the **ON** button to turn on the COD PLUS Colorimeter. The LaMotte logo will appear for about 2 seconds and the the Start screen appears. Press the ***/ENTER** button to begin testing.

VER 1.0
COD PLUS
* Start

2. The **MAIN MENU** will appear. Press the ***/ENTER** button to select Testing Menu.

MAIN MENU
*Testing Menu
Editing Menu
PC Link

3. Scroll with the ▼ or ▲ buttons and make a selection with the ***/ENTER** button. **All Tests** has all the available tests. The three sequences have selected tests and **Absorbance** has %T/ABS tests.

TESTING MENU
*All Tests
Sequence 1
Sequence 2
Sequence 3
Absorbance

■ SEQUENCES OF TESTS

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.

SEQUENCE 1
*004 Ammonia-N LF
005 Ammonia-N LS
006 Ammonia-N H
007 Boron
001 COD LR
002 COD SR
003 COD HR
009 Color
013 DO
014 Fluoride
018 Ozone-LR
020 Phosphate-L
025 Sulfate-HR
026 Sulfide-LR
028 Turbidity

SEQUENCE 2
*008 Cobalt
010 Cu Cuprizone
011 Cu - DDC
015 Hydrazine
016 Moly HR
017 Nickel
018 Ozone-LR
021 Phosphate-H
022 Potassium
023 Silica-Lo
024 Silica-Hi
027 Tannin
029 Zinc-LR

SEQUENCE 3
*001 COD LR
002 COD SR
003 COD HR

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, use the ▼ button to scroll to the next test and press the ***/ENTER** button 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. 32).

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

Pressing the **OFF** button 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.

■ TESTING WITH THE LaMOTTE PRE-PROGRAMMED TESTS

Press ON to turn on the COD PLUS Colorimeter. The LaMotte logo will appear for about 2 seconds and then the Start screen appears. Press the ***/ENTER** button to start testing.

VER 1.0
COD PLUS
*Start

The MAIN MENU will appear. Press the ***/ENTER** button to select Testing Menu.

MAIN MENU
*Testing Menu
Editing Menu
PC Link

Press the ***/ENTER** button to select All Tests.

TESTING MENU
*All Tests
Sequence 1
Sequence 2

Press the ▼ button to move to the 001 COD LR to *.

ALL TESTS
*001 COD LR
002 COD SR
003 COD HR

Press the ***/ENTER** button to select 001 COD LR.

ALL TESTS
*001 COD LR
002 COD SR
003 COD HR

The COD PLUS Colorimeter is ready to scan at the correct wavelength. Place the blank in the sample chamber, close the lid and press the ***/ENTER** button to scan blank.

NOTE: Do not keep the button depressed.

001 COD LR
*Scan Blank

The screen will display **Blank Done** for about 1 second. **Scan Sample** will be positioned next to *****.

001 COD LR
Blank Done
*Scan Blank

Place the reacted sample in the chamber, close the lid and press the ***/ENTER** button to scan sample. The colorimeter will scan the sample and the results screen will appear.

001 COD LR
*Scan Sample

Record test result. To repeat the test, press the ***/ENTER** button to scan the sample again. The last blank scanned is used to zero the colorimeter for repeated scans. A different blank can be used by pressing the **▲** button to scroll back to **Scan Blank** and then scanning another blank. Scroll with the **▼** or **▲** buttons and make another selection with the ***/ENTER** button. The %T or Absorbance of the last test can be viewed by choosing **%T/Abs**. Press the **EXIT** button to escape to previous menus.

NOTE: The menu loop in this screen so either the **▲** or **▼** buttons will lead to the menu selection needed.

001 COD LR
100 mgL
*Scan Blank
Next Test
Previous Test
%/Abs
Scan Blank

■ 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. Use 0.10 ppm aluminum.

Use the ▲ or ▼ button to scroll to 002 Aluminum. Follow instructions in the COD PLUS Manual for testing the aluminum standard. Scan the blank.

002 Aluminum
*Scan Blank

The screen will display Blank Done for about 1 second. Scan Sample will be positioned next to *.

002 Aluminum
Blank Done
*Scan Sample

Place the reacted sample in the chamber, close the lid and press ***/ENTER** to scan sample. The result will be displayed.

002 Aluminum
*Scan Sample

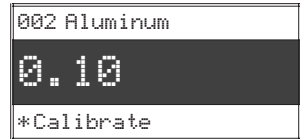
The displayed result can now be standardized. Use the ▲ or ▼ buttons to scroll to Calibrate. Press ***/ENTER** to select.

002 Aluminum
0.09 ppm
*Scan Sample
Next Test
Previous Test
%T/Abs
Calibrate
Scan Blank

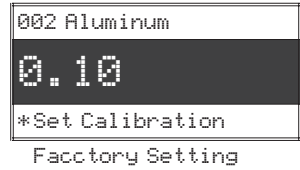
A reverse font (dark background with light characters) will appear to indicate that the reading can be adjusted. Use ▲ or ▼ to scroll to the concentration of the sample, 0.10 ppm in this example.



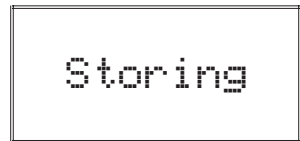
Set the calibration by pressing ***/ENTER** to select Calibrate.



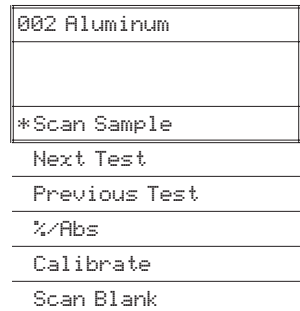
Two menu choices will be offered, Set Calibration and Factory Setting. Set the calibration by pressing ***/ENTER** to select Set Calibration; or use ▲ or ▼ to scroll to and select Factory Setting to revert to the factory calibration.



The meter will display the message “Storing” and return to 002 Aluminum test.



The calibration for 002 Aluminum has now been standardized and can be used for testing. The standardization can be removed by repeating the calibration and selecting Factory Setting.



■ MEASURING IN THE ABSORBANCE MODE

Press **ON** to turn on the COD PLUS Colorimeter. The LaMotte logo will appear for about 2 seconds and then the Start screen appears. Press the ***/ENTER** button to start testing.

VER 1.0
COD PLUS
*Start

The MAIN MENU will appear. Press the ***/ENTER** button to select Testing Menu.

MAIN MENU
*Testing Menu
Editing Menu
PC Link

Press the ▼ button to scroll to Absorbance.

TESTING MENU
All Tests
Sequence 1
Sequence 2
Sequence 3
*Absorbance

Press the ***/ENTER** button to select Absorbance.

TESTING MENU
*Absorbance

Press the ▼ or ▲ buttons to move to the desired test.

Absorbance
*101
102 End of List
103 Abs 430
104 Abs 620

Press the ***/ENTER** button to select test.

Absorbance
*103 Abs 430
104 Abs 620

Insert blank, press the ***/ENTER** button to scan blank.

103 Abs 430
*Scan Blank

The screen will display **Blank Done** for about 1 second.

103 Abs 430
Blank Done
*Scan Blank

Insert the reacted sample. Press the ***/ENTER** button to scan the sample.

103 Abs 430
*Scan Sample

Record test result. To repeat the test, press the ***/ENTER** button to scan the sample again. The last blank scanned is used to zero the colorimeter for repeated scans. A different blank can be used by pressing the **▲** button to scroll back to **Scan Blank** and then scanning another blank. Scroll with **▼** or **▲** 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.

103 Abs 430
0.95
*Scan Sample
Next Test
Previous Test
%T/Abs
Scan Blank

NOTE: The menus loop in this screen so either **▼** or **▲** will lead to the menu selection needed.

EDITING MENU

The EDITING MENU allows the user to edit sequences, edit user tests, set the clock, edit the logging function, and set the power saving function.

■ EDIT A SEQUENCE

The EDIT SEQUENCE menu allows three alterable test sequences (SEQUENCE 1, SEQUENCE 2, and SEQUENCE 3) to be edited.

Press ON to turn on the COD PLUS Colorimeter. The LaMotte logo will appear for about 2 seconds and then the Start screen appears. Press the ***/ENTER** button to start testing.

VER 1.0
COD PLUS
*START

The Main Menu will appear. Press the ▼ button to scroll to Editing Menu.

MAIN MENU
*Testing Menu
Editing Menu
PC Link

Press the ***/ENTER** button to select Editing Menu.

MAIN MENU
*Editing Menu
PC Link

The Editing Menu appears. Press the ***/ENTER** button to select Editing Sequence.

EDITING MENU
*Edit Sequence
Edit User Test
Set Clock

The Edit Sequence menu appears. Press the ***/ENTER** button to scroll to select Edit Sequence 1.

EDIT SEQUENCE
*Edit Sequence 1
Edit Sequence 2
Edit Sequence 3

Sequence 1 appears.

EDIT SEQUENCE 1
*004 Ammonia-NLF
005 Ammonia-NLS
006 Ammonia-NH

■ ADDING OR DELETING TESTS

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.

Below is a step by step example of how to add a test to `SEQUENCE 1` starting from the `EDIT SEQUENCE 1` menu.

Press the ▼ button to scroll to `005 Ammonia-NLS`.

EDIT SEQUENCE 1
004 Ammonia-NLF
005 Ammonia-NLS
*006 Ammonia-NH

Press the ***/ENTER** button to select `005 Ammonia-NLS`.

EDIT SEQUENCE 1
*005 Ammonia-NLS
006 Ammonia-NH
007 Boron

Press the ***/ENTER** button to select *Insert Before*.

EDIT SEQUENCE 1
*Insert Before
Insert After
Delete

The `ALL TESTS` menu appears. Press the ▼ button to move the `001 COD LR` to `*`.

ALL TESTS
*001 COD LR
002 COD SR
003 COD HR

Continued...

Press the ***/ENTER** button to select 001 COD LR.

ALL TESTS
*001 COD LR
002 COD SR
003 COD HR

Sequence 1 appears in EDIT SEQUENCE 1 menu and 001 COD LR is now before 005 Ammonia-NLS in the sequence. All changes to Sequence 1 are automatically saved. Press the **EXIT** button to exit the EDIT SEQUENCE 1 menu and return to the EDIT SEQUENCE menu or continue editing.

EDIT SEQUENCE 1
*004 Ammonia-NLF
001 COD LR
005 Ammonia-NLS
006 Ammonia-NH
007 Boron

The EDIT SEQUENCE menu appears. Select another sequence to edit or press the **EXIT** button to return to the EDITING MENU. Press the **EXIT** button again to return to the MAIN MENU.

EDIT SEQUENCE 1
*Edit Sequence 1
Edit Sequence 2
Edit Sequence 3

Below is a step by step example of how to delete a test from SEQUENCE 1 starting from the EDIT SEQUENCE 1 menu. The test 001 COD LR, added in the previous example, will be deleted.

Press the **▼** button to scroll to 001 COD LR.

EDIT SEQUENCE 1
004 Ammonia-NLF
*001 COD LR
005 Ammonia-NLS
006 Ammonia-NH
007 Boron

Press the ***/ENTER** button to select 001 COD LR.

EDIT SEQUENCE 1
*001 COD LR
005 Ammonia-NLS
006 Ammonia-NH

Press the ▼ button to scroll to Delete.

EDIT SEQUENCE 1
*Insert Before
Insert After
Delete

Press the */ENTER button to select Delete.

EDIT SEQUENCE 1
*Delete

Sequence 1 appears in the EDIT SEQUENCE 1 menu and 002 Aluminum has been deleted. All changes to SEQUENCE 1 are automatically saved.

Press the EXIT button to exit the EDIT SEQUENCE 1 menu and return to the EDIT SEQUENCE menu or continue editing.

EDIT SEQUENCE 1
*004 Ammonia-NLF
005 Ammonia-NLS
006 Ammonia-NH
007 Boron

The EDIT SEQUENCE menu appears. Select another sequence to edit or press the EXIT button to return to the EDITING MENU. Press the EXIT button again to return the the MAIN MENU.

EDIT SEQUENCE 1
*Edit Sequence 1
Edit Sequence 2
Edit Sequence 3

■ 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 10 User Tests. These tests are originally named "User Test 1 - 10". 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, see CALIBRATION CURVES, p. 13). Prepare these solutions 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.

To edit a User Test, start at the EDITING MENU.
Scroll down to Edit User Test.

EDITING MENU
*Edit Sequences
Edit User Test
Set Clock

Press the ***/ENTER** button to select the Edit User Test.

EDITING MENU
*Edit User Test
Set Clock
Edit Logging

From the EDIT USER TEST menu, select the User Test to be entered or changed. In this example, choose 105 User Test 01. Use the ▼ and ▲ buttons to scroll to other User Tests if desired. Select the User Test by pressing the ***/ENTER** button.

EDIT USER TEST
*105 User Test01
106 User Test02
107 User Test03
108 User Test04
: : :
114 User Test10

■ NAMING THE TEST

A User Test can be up to 11 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 (SP), a dash (-) and a decimal point (.). The existing name is displayed on the bottom line of the display. A cursor will be over the character which is to be edited and that character is also displayed in the center of the display. The character can be changed by using the ▼ and ▲ buttons to scroll to other characters. Use the ***/ENTER** button to select a character. The edited name is saved at any time by pressing **EXIT** or by pressing the ***/ENTER** button after selecting the eleventh character.

From the Edit User Test01 menu press the ***/ENTER** button to select Name The Test and change the name of User Test 01.

EDIT USER TEST01
*Name The Test
Select Vial/WL
New Calibration
Decimal Places
Select Units

The cursor is over the letter "U" in 105 User Test01 and the letter "U" is displayed in the large font in the center of the display.

NAME THE TEST
U
105 User Test01

Change the name to H2O. Use the ▼ and ▲ buttons to scroll to the letter "H" into the center of the display. Press the ***/ENTER** button to select the letter "H".

NAME THE TEST
H
105 User Test01

The letter "H" has been entered in the first position of the name and the cursor has moved to the second letter "S".

NAME THE TEST
S
105 User Test01

Use the ▼ and ▲ buttons to scroll to the number "2" into the center of the display. Press the ***/ENTER** button to select the number "2".

NAME THE TEST
2
105 Hser Test01

Continued...

The number “2” has been entered in the second position of the name and the cursor has moved to the third letter “e”.

NAME THE TEST
2 e
105 H2er Test01

Use the ▼ and ▲ buttons to scroll to the letter “0” into the center of the display. Press the ***/ENTER** button to select the letter “0”.

NAME THE TEST
0
105 H20r Test01

The letter “0” has been entered in the third position of the name and the cursor has moved to the fourth letter “r”. Press the **EXIT** button to save the name entered up to this point.

NAME THE TEST
r
*105 H20r Test01

The meter will display the message “Storing” and return to the EDIT USER TEST01 menu.

Storing

EDIT USER TEST01
*Name The Test
Select The Vial/WL
New Calibration
Decimal Places
Select Units

■ SELECTING THE VIAL AND WAVELENGTH

The COD PLUS Colorimeter uses three different vials (the 25 mm 0290 tube, UDV's and COD tubes) and 2 different wavelengths (430 and 620 nm). The colorimeter uses different settings for each of the combinations of vial and wavelength. These twelve settings are called channels. Choose the channel with the correct wavelength and vial for the test.

NOTE: 520 nm and 570 nm are not available in the COD PLUS.

Use the ▼ button to scroll to `Select Vial/WL` and press ***/ENTER** button to select.

EDIT USER TEST01
*Name The Test
Select Vial/WL
New Calibration
Decimal Places
Select Units

Use the ▼ and ▲ buttons to scroll to the appropriate channel and press ***/ENTER** button to select.

NOTE: This is a looping menu.

: : :
Ch11 620nm COD
Ch12 570nm COD
SELECT CHANNEL
*Ch1 520nm 25mm
Ch2 430nm 25mm
Ch3 620nm 25mm
Ch4 570nm 25mm
Ch5 520nm UDV
Ch6 430nm UDV
: : :

The meter will display the message "Storing" and return to the `EDIT USER TEST01` menu.

Storing

EDIT USER TEST01
*Select The Vial/WL
New Calibration
Decimal Places
Select Units

■ ENTERING A NEW CALIBRATION

To enter a new calibration two reacted standards solutions of known concentration are required: a “low standard” and a “high standard”. These should be ready to use.

Use the ▼ button to scroll to New Calibration and press ***/ENTER** button to select.

EDIT USER TEST01
*Select Vial/WL
New Calibration
Decimal Places
Select Units

Input the concentration of the LOW STANDARD by using the ▼ and ▲ buttons to scroll the first digit of the concentration into the first position on the display. Press ***/ENTER** button to select that digit (1 for this example).

LOW STANDARD
0_____
*Continue

The number “0” is always the starting point for the next digit. Continue selecting digits or a decimal point to enter the concentration (up to seven characters).

LOW STANDARD
10_____
*Continue

“1.5” has been entered in this example. Press ***/ENTER** button four times to input “0” as the last four digits. Pressing ***/ENTER** after selecting the last digit saves the concentration.

LOW STANDARD
1.50_____
*Continue

Input the concentration of the HIGH STANDARD by using the same method as for the low standard.

HIGH STANDARD
0_____
*Continue

Place a clear blank in the sample chamber. Press the ***/ENTER** button to scan the blank.

Insert Blank
*Continue

The screen will display Blank Done for about 1 second.

Blank Done
*Scan Blank

Place the reacted low standard in the sample chamber. Press ***/ENTER** to scan the low standard.

Insert Lo Standard
*Continue

Place the reacted high standard in the sample chamber. Press ***/ENTER** to scan the high standard.

Insert Hi Standard
*Continue

The meter will display the message “Storing” and return to the EDIT USER TEST01 menu.

Storing

EDIT USER TEST01
*New Calibration
Decimal Places
Select Units

■ 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). Menu choices of 0, 1, 2, or 3 decimal places will be given for the display.

Use the ▼ button to scroll to `Decimal Places` and press ***/ENTER** button to select.

EDIT USER TEST01	
*New Calibration	
Decimal Places	
Select Units	

Use the ▼ button to scroll to the number of decimal places to be shown and press ***/ENTER** to select.

DECIMAL PLACES?	
*None	0
One	0.0
Two	0.00
Three	0.000

The meter will display the message "Storing" and return to the `EDIT USER TEST01` menu.

Storing

EDIT USER TEST01	
*Decimal Places	
Select Units	

■ SELECTING THE UNITS OF CONCENTRATION

The COD PLUS Colorimeter has seven options for units of concentration. They are No Units, ppm, pH, FTU, ppb, ppt and mgL.

Use the ▼ button to scroll to `Select Units` and press ***/ENTER** to select.

EDIT USER TEST01
*Decimal Places
Select Units

Use the ▼ button to scroll to the appropriate unit and press ***/ENTER** to select.

SELECT UNITS
*No Units
ppm
pH
FTU
ppb
ppt
mgL

The meter will display the message “Storing” and return to the `EDIT USER TEST01` menu.

Storing

EDIT USER TEST01
*Select Units

■ SETTING THE CLOCK

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

From the EDITING MENU use the ▼ button to scroll to Set Clock. Press ***/ENTER** to select.

EDITING MENU
*Edit Sequences
Edit User Test
Set Clock
Editing Logging
Factory Setup
Set PWR Save

The current date and time are displayed as month - day - year on the first line and as hours : minutes : seconds on the second line. A two-digit number is displayed for each setting. Use the ▼ and ▲ buttons to scroll to the appropriate number and press ***/ENTER** to select. The cursor will move to the next digit. Set all subsequent numbers in the same manner. Selecting the final digit in the seconds field stores the date and time and returns to the EDITING MENU.

SET TIME
MM - DD - YY
HH : MM : SS

EDITING MENU
*Set Clock
Editing Logging
Factory Setup
Set PWR Save

NOTE: These are looping menus.

■ TURNING THE DATA LOGGER ON AND OFF

The default setting for the datalogger is “Enabled” or turned off. If there is no need for data logging, this setting is suggested. If data logging is needed, the data logger can be “Enabled” or turned on.

From the EDITING MENU use the ▼ button to scroll to Edit Logging. Press ***/ENTER** to select.

EDITING MENU
*Edit Sequences
Edit User Test
Set Clock
Editing Logging
Factory Setup
Set PWR Save

The current setting is always displayed next to the *. To change the setting, use the ▼ or ▲ buttons to scroll to the other setting. Press ***/ENTER** to select.

EDIT LOGGING
*Enabled
Disabled

The meter will display the message “Storing” and return to the EDITING MENU.

Storing

EDITING MENU
*Editing Logging
Factory Setup
Set PWR Save

■ FACTORY SETUP

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

■ SETTING THE POWER SAVING FUNCTION

The COD PLUS Colorimeter has a power saving function that turns the meter off after an interval of inactivity. If no buttons have been pressed during that interval the meter will turn itself off. This interval can be disabled or set for 5, 15, 30 or 60 minutes. The default setting is 5 minutes.

From the EDITING MENU use the ▼ button to scroll to Set PWR Save. Press ***/ENTER** to select.

EDITING MENU
*Edit Sequences
Edit User Test
Set Clock
Editing Logging
Factory Setup
Set PWR Save

The current setting is always displayed next to the *. To change the setting, use the ▼ or ▲ buttons to scroll to the appropriate setting. Press ***/ENTER** to select.

Disabled
AUTO SHUTOFF
*5 Minutes
15 Minutes
30 Minutes
60 Minutes

The meter will display the message “Storing” and return to the EDITING MENU.

Storing

EDITING MENU
*Set PWR Save

PC LINK

The COD PLUS Colorimeter may be interfaced with any Windows-based computer by using the LaMotte SMARTLink2 Program and Interface Cable (Order Code 1912-3 [3.5 disk] or 1912-CD [compact disk]). The program stores customer information and test data in a database. It can be used to download data stored in the COD PLUS datalogger for each test site.

The colorimeter may also be interfaced with an RS-232 serial printer, using an interface cable (Order Code 1772) and setting the printer configuration to the Output as described below.

Choose PC Link from the Main Menu. The user can download the entire datalogging buffer. Downloading does not delete or empty the datalogger.

■ OUTPUT

RS-232 compatible, asynchronous serial, 9600 baud, no parity, 8 data bits, 1 stop bit.

■ COMPUTER CONNECTION

RS-232 interface connection, 8 pin mini-DIN/9 pin F D-submin. (Order Code 1772).

BATTERY OPERATION

The colorimeter may be run on battery power or AC using the AC adapter. If using the meter as a benchtop unit, keep it plugged in if possible. If used on only battery power, always have a spare battery on hand.

If the battery power is low, the COD PLUS will display "LOW BATT" and turn off.



LOW BATT

■ REPLACING THE BATTERY

The COD PLUS Colorimeter uses a standard 9-volt alkaline battery that is available worldwide. The battery compartment is located on the bottom of the the case.

To replace the battery:

1. Open the battery compartment lid.
2. Remove the battery and disconnect the battery from the polarized plug.
3. Carefully connect the new battery to the polarized plug and insert it into the compartment.
4. Close the battery compartment lid.

MAINTENANCE

■ CLEANING

Clean with a damp, lint-free cloth.

DO NOT ALLOW WATER TO ENTER THE COLORIMETER CHAMBER OR ANY OTHER PARTS OF THE METER.

TROUBLESHOOTING GUIDE

■ 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, p. 16).

If **OVERRANGE** is displayed, press the ***/ENTER** button to continue testing on diluted samples.



■ HELPFUL HINTS

■ STRAY LIGHT

The COD 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.

COD PLUS COLORIMETER REAGENT SYSTEMS

■ COD PLUS REAGENT SYSTEMS LIST

Test #	Test Factor	Range(ppm)	Test Method (# of Reagents)	# of Tests
1	COD-Low Range	5-150	Digestion (1)	25
2	COD-Standard Range	0-1500	Digestion (1)	25
3	COD-High Range	0-15000	Digestion (1)	25
4	Ammonia Nitrogen-Low Range, Fresh Water	0.00-1.00	Salicylate (3)	50
5	Ammonia Nitrogen-Low Range, Salt Water	0.00-1.00	Salicylate (3)	25
6	Ammonia Nitrogen-High Range	0.00-4.00	Nesslerization (2)	
7	Boron	0.00-0.80	Azomethine-H (2)	50
8	Cobalt	0.00-2.00	PAN (3)	50
9	Color	0-1000	Platinum Cobalt (0)	∞
10	Copper-Cuprizone	0.00-2.00	Cuprizone (2)	50
11	Copper-DDC	0.00-6.00	Diethyldithiocarbamate (1)	100
12	Cyanuric Acid	5-200	Melamine (1)	50
13	Dissolved Oxygen	0.0-11.0	Winkler colorimetric (3)	300
14	Fluoride	0.00-2.00	SPADNS (2)	50
15	Hydrazine	0.00-1.00	P-dimethylaminobenzaldehyde (2)	50
16	Molybdenum-High Range	0.0-50.0	Thioglycolate (3)	50
17	Nickel	0.00-8.00	Dimethylglyoxime (6)	50
18	Ozone-Low Range	0.00-0.40	Indigo (3)	100
19	Ozone-High Range	0.00-2.50	Indigo (3)	50
20	Phosphate-Low Range	0.00-3.00	Ascorbic Acid Reduction (2)	50
21	Phosphate-High Range	0.0-70.0	Vanodomolybdphosphoric Acid (1)	50
22	Potassium	0.0-10.0	Tetraphenylboron (2)	100
23	Silica-Low Range	0.0-4.0	Heteropoly Blue (4)	50
24	Silica-High Range	0-75	Silicomolybdate (3)	50
25	Sulfate-High Range	0-100	Barium Chloride (1)	50
26	Sulfide-Low Range	0.00-1.50	Methylene Blue (3)	50
27	Tannin	0.0-10.0	Tungsto-molybdophosphoric Acid (2)	50
28	Turbidity	0-400	Absorption (0)	∞
29	Zinc-Low Range	0.00-3.00	Zincon (6)	50



TEST INSTRUCTIONS



COD PLUS COLORIMETER TEST PROCEDURES

■ TABLE OF CONTENTS

- COD - Low Range
- COD - Standard Range
- COD - High Range
- Ammonia Nitrogen - Low Range, Fresh Water
- Ammonia Nitrogen - Low Range, Salt Water
- Ammonia Nitrogen - High Range
- Boron
- Cobalt
- Color
- Copper - Cuprizone
- Copper - DDC
- Cyanuric Acid
- Dissolved Oxygen
- Fluoride
- Hydrazine
- Molybdenum - High Range
- Nickel
- Ozone - Low Range
- Ozone - High Range
- Phosphate - Low Range
- Phosphate - High Range
- Potassium
- Silica - Low Range
- Silica - High Range
- Sulfate - High Range
- Sulfide - Low Range
- Tannin
- Turbidity
- Zinc - Low Range
- Appendix

COD - LOW RANGE

MERCURY FREE DIGESTION • CODE 5-0072 MERCURY DIGESTION • CODE 5-0075

QUANTITY	CONTENTS	CODE
25	*COD Low Range Mercury Free Tubes	*5-0072
or 25	*COD Low Range Mercury Tubes	*5-0075

*WARNING: Reagent marked with a * are considered hazardous substances. Material Safety Data Sheets (MSDS) are supplied for these reagents. For your safety read label and accompanying MSDS before using.

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, 8 vial, 110V	5-0069
or 1	COD Reactor, 8 vial, 220V	5-0070
or 1	COD Reactor, 25 vial, 110/220V	5-0094
1	Volumetric Pipet, 2.0 mL	2-2168
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: 5 - 150 mg/L COD

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 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 O₂ per ppm NO₂-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. The COD adapter minimizes stray light. To further reduce stray light interference, do not scan sample in direct sunlight.

PROCEDURE

Use COD adapter (see p. 22).

1. Homogenize sample if necessary.
2. Preheat COD heater block to $150\pm 2^{\circ}\text{C}$.
3. Remove cap from COD tube vial. Hold vial 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 vial.
4. Cap and mix thoroughly.
5. Rinse the outside of the vial 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 vials in preheated COD block heater and maintain temperature at $150\pm 2^{\circ}\text{C}$ for two hours.
8. At the end of the heating period turn the heater off. Wait 20 minutes for the vials to cool to 120°C or less.
9. Remove vials from block heater. Invert several times to mix.
10. Allow to cool to room temperature.
11. Press and hold **ON** button until colorimeter turns on.
12. Press **ENTER** to start.
13. Press **ENTER** to select TESTING MENU.
14. Select ALL TESTS (or a sequence containing 1 COD LR) from PROGRAMMED TESTS menu.
15. Scroll to and select 1 COD LR from menu.
16. Wipe the blank vial with a damp towel to remove fingerprints and smudges. Wipe with a dry towel.
17. Insert reagent blank tube into chamber. Align the center of the LaMotte logo on the tube with the arrow shaped mark molded into the housing at the front edge of the light chamber. Select SCAN BLANK.
18. Remove tube from colorimeter.
19. Insert digested water sample tube into chamber. Position the tube as instructed above. Select SCAN SAMPLE. Record result. For the most accurate results, take three readings on each sample and average the results.
20. Press **OFF** button to turn colorimeter off or press **EXIT** button 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 • CODE 5-0073 MERCURY DIGESTION • CODE 5-0076

QUANTITY	CONTENTS	CODE
25	*COD Standard Range Mercury Free Tubes	*5-0073
or 25	*COD Standard Range Mercury Tubes	*5-0076

*WARNING: Reagent marked with a * are considered hazardous substances. Material Safety Data Sheets (MSDS) are supplied for these reagents. For your safety read label and accompanying MSDS before using.

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, 8 vial, 110V	5-0069
or 1	COD Reactor, 8 vial, 220V	5-0070
or 1	COD Reactor, 25 vial, 110/220V	5-0094
1	Volumetric Pipet, 2.0 mL	2-2168
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

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 O₂ per ppm NO₂-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. The COD adapter minimizes stray light. To further reduce stray light interference, do not scan sample in direct sunlight.

PROCEDURE

Use COD adapter (see p. 22).

1. Homogenize sample if necessary.
2. Preheat COD heater block to $150\pm 2^{\circ}\text{C}$.
3. Remove cap from COD tube vial. Hold vial 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 vial.
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 vials in preheated COD block heater and maintain temperature at $150\pm 2^{\circ}\text{C}$ for two hours.
8. At the end of the heating period turn the heater off. Wait 20 minutes for the vials to cool to 120°C or less.
9. Remove vials from block heater. Invert several times to mix.
10. Allow to cool to room temperature.
11. Press and hold **ON** button until colorimeter turns on.
12. Press **ENTER** to start.
13. Press **ENTER** to select TESTING MENU.
14. Select ALL TESTS (or a sequence containing 2 COD SR) from PROGRAMMED TESTS menu.
15. Wipe the blank vial with a damp towel to remove fingerprints and smudges. Wipe with a dry towel.
16. Scroll to and select 2 COD SR from menu.
17. Insert reagent blank tube into chamber. Align the center of the LaMotte logo on the tube with the arrow shaped mark molded into the housing at the front edge of the light chamber. Select SCAN BLANK.
18. Remove tube from colorimeter.
19. Insert digested water sample tube into chamber. Position the tube as instructed above. Select SCAN SAMPLE. Record result. For the most accurate results, take three readings on each sample and average the results.
20. Press **OFF** button to turn colorimeter off or press **EXIT** button 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 • CODE 5-0074 MERCURY DIGESTION • CODE 5-0077

QUANTITY	CONTENTS	CODE
25	*COD High Range Mercury Free Tubes	*5-0074
or 25	*COD High Range Mercury Tubes	*5-0077

*WARNING: Reagent marked with a * are considered hazardous substances. Material Safety Data Sheets (MSDS) are supplied for these reagents. For your safety read label and accompanying MSDS before using.

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, 8 vial, 110V	5-0069
or 1	COD Reactor, 8 vial, 220V	5-0070
or 1	COD Reactor, 25 vial, 110/220V	5-0094
1	Volumetric Pipet, 2.0 mL	2-2168
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

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 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 O₂ per ppm NO₂-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. The COD adapter minimizes stray light. To further reduce stray light interference, do not scan sample in direct sunlight.

PROCEDURE

Use COD adapter (see p. 22).

1. Homogenize sample if necessary.
2. Preheat COD heater block to $150\pm 2^{\circ}\text{C}$.
3. Remove cap from COD tube vial. Hold vial 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 vial.
4. Cap and mix thoroughly.
5. Rinse the outside of the vial 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 vials in preheated COD block heater and maintain temperature at $150\pm 2^{\circ}\text{C}$ for two hours.
8. At the end of the heating period turn the heater off. Wait 20 minutes for the vials to cool to 120°C or less.
9. Remove vials from block heater. Invert several times to mix.
10. Allow to cool to room temperature.
11. Press and hold **ON** button until colorimeter turns on.
12. Press **ENTER** to start.
13. Press **ENTER** to select TESTING MENU.
14. Select ALL TESTS (or a sequence containing 3 COD HR 0-15000) from PROGRAMMED TESTS menu.
15. Wipe the blank vial with a damp towel to remove fingerprints and smudges. Wipe with a dry towel.
16. Scroll to and select 3 COD HR 0-15000 from menu.
17. Insert reagent blank tube into chamber. Align the center of the LaMotte logo on the tube with the arrow shaped mark molded into the housing at the front edge of the light chamber. Select SCAN BLANK.
18. Remove tube from colorimeter.
19. Insert digested water sample tube into chamber. Position the tube as instructed above. Select SCAN SAMPLE. Record result. For the most accurate results, take three readings on each sample and average the results.
20. Press **OFF** button to turn colorimeter off or press **EXIT** button 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
5 g	*Salicylate #3	*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 * are considered hazardous substances. Material Data Safety Sheets (MSDS) are supplied for these reagents. For your safety, read label and accompanying MSDS before using.

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

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 **ON** button until colorimeter turns on.
2. Press **ENTER** to start.
3. Press **ENTER** to select TESTING MENU.
4. Select ALL TESTS (or another sequence containing 4 Ammonia-NLF) from TESTING MENU.
5. Scroll to and select 4 Ammonia-NLF from menu.
6. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
7. Insert tube into chamber, close lid and select SCAN BLANK. (See Note.)
8. 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.
9. Use the 0.15 g spoon (0727) to add two measures of *Salicylate #2 Reagent (7457). Cap and mix until dissolved. Wait 1 minute.
10. 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.
11. At the end of the 12 minute waiting period, immediately mix and insert tube into chamber, close lid and select SCAN SAMPLE. Record result.
12. Press **OFF** button to turn colorimeter off or press **EXIT** button to exit to a previous menu or make another menu selection.

CALCULATIONS:

To express results as Unionized Ammonia (NH₃):

$$\text{ppm Unionized Ammonia (NH}_3\text{)} = \text{ppm Ammonia-Nitrogen (NH}_3\text{-N)} \times 1.2$$

To express results as Ionized Ammonia (NH₄):

$$\text{ppm Ionized Ammonia (NH}_4^+\text{)} = \text{ppm Ammonia-Nitrogen (NH}_3\text{-N)} \times 1.3$$

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

NOTE: For the 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.

PROCEDURE - SALT WATER

1. Press and hold **ON** button until colorimeter turns on.
2. Press **ENTER** to start.
3. Press **ENTER** to select TESTING MENU.
4. Select ALL TESTS (or another sequence containing 5 Ammonia-NLS) from TESTING MENU.
5. Scroll to and select 5 Ammonia-NLS from menu.
6. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
7. Insert tube into chamber, close lid and select SCAN BLANK. (See Note.)
8. 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.
9. Use the 0.15 g spoon (0727) to add two measures of *Salicylate #2 Reagent (7457). Cap and mix until dissolved. Wait 1 minute.
10. 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.
11. At the end of the 20 minute waiting period, immediately mix and insert tube into chamber, close lid and select SCAN SAMPLE. Record result.
12. Press **OFF** button to turn colorimeter off or press **EXIT** button to exit to a previous menu or make another menu selection.

CALCULATIONS:

To express results as Unionized Ammonia (NH₃):

$$\begin{aligned} \text{ppm Unionized Ammonia (NH}_3\text{)} &= \\ \text{ppm Ammonia-Nitrogen (NH}_3\text{-N)} &\times 1.2 \end{aligned}$$

To express results as Ionized Ammonia (NH₄⁺):

$$\begin{aligned} \text{ppm Ionized Ammonia (NH}_4^+\text{)} &= \\ \text{ppm Ammonia-Nitrogen (NH}_3\text{-N)} &\times 1.3 \end{aligned}$$

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

NOTE: For the 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.

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 a * are considered hazardous substances. Material Safety Data Sheets (MSDS) are supplied for these reagents. For your safety read label and accompanying MSDS before using.

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

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 **ON** button until colorimeter turns on.
2. Press **ENTER** to start.
3. Press **ENTER** to select TESTING MENU.
4. Scroll to and select ALL TESTS (or another sequence containing 6 Ammonia-NH) from TESTING MENU.
5. Scroll to and select 6 Ammonia-NH from menu.
6. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
7. Insert tube into chamber, close lid and select SCAN BLANK. (See Note)
8. Remove tube from colorimeter. Add 8 drops of Ammonia Nitrogen Reagent #1 (V-4797). Cap and mix. Wait 1 minute.
9. 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.
10. At end of the 5 minute waiting period, immediately mix, insert tube into chamber, close lid and select SCAN SAMPLE. Record result.
11. Press **OFF** button to turn the colorimeter off or press the **EXIT** button exit to a previous menu or make another menu selection.

CALCULATIONS:

To express results as Unionized Ammonia (NH₃):

$$\text{ppm Unionized Ammonia (NH}_3\text{)} = \text{ppm Ammonia-Nitrogen (NH}_3\text{-N)} \times 1.2$$

To express results as Ionized Ammonia (NH₄):

$$\text{ppm Ionized Ammonia (NH}_4^+\text{)} = \text{ppm Ammonia-Nitrogen (NH}_3\text{-N)} \times 1.3$$

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

NOTE: For the 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.

BORON

AZOMETHINE-H METHOD • CODE 4868

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

*WARNING: Reagents marked with a * are considered hazardous substances. Material Safety Data Sheets (MSDS) are supplied for these reagents. For your safety read label and accompanying MSDS before using.

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

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. Press and hold **ON** button until colorimeter turns on.
2. Press **ENTER** to start.
3. Press **ENTER** to select Testing Menu.
4. Select ALL TESTS (or another sequence containing 7 Boron) from TESTING MENU.
5. Scroll to and select 7 Boron from menu.
6. Rinse a tube (0290) with sample water. Fill to 10 mL line with sample.
7. Insert the tube into chamber, close lid and select SCAN BLANK.
8. Remove the tube from colorimeter.
9. Use the 1.0 mL pipet (0354) to add 2 mL of *Boron Buffer (4869). Cap and mix.
10. 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.
11. Cap and shake vigorously for 30 seconds.
12. Insert the tube into chamber. Close lid.
13. Wait 30 minutes. Do not open the lid during the waiting time. The reaction is photosensitive.
14. Remove tube from chamber. Invert several times to mix.
15. Insert tube into chamber, close lid and select SCAN SAMPLE. Record result in ppm boron.
16. Press **OFF** button to turn the colorimeter off or press **EXIT** button 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 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.

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

*WARNING: Reagent marked with a * are considered hazardous substances. Material Safety Data Sheets (MSDS) are supplied for these reagents. For your safety read label and accompanying MSDS before using.

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: 0.0 – 2.0 ppm cobalt

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 **ON** button until colorimeter turns on.
2. Press **ENTER** to start.
3. Press **ENTER** to select TESTING MENU.
4. Select All Tests (or another sequence containing 8 Cobalt) from TESTING MENU.
5. Scroll to and select 8 Cobalt from menu.
6. Rinse a tube (0290) with sample water. Fill to 10 mL with sample.
7. Insert the tube into chamber, close lid and select SCAN BLANK.
8. Remove the tube from colorimeter.
9. Use the 1.0 mL pipet (0354) to add 1 mL of *Cobalt Buffer (4852). Cap and mix.
10. Use the other 1.0 mL pipet (0354) to add 1 mL of *Cobalt Indicator Reagent (4853). Cap and mix.
11. Wait 3 minutes.
12. Use the 0.5 mL pipet (0353) to add 0.5 mL *Stabilizer Solution (4854). Cap and invert 15 times to thoroughly mix.
13. Wait 5 minutes. DO NOT MIX.
14. Insert tube into chamber, close lid and select SCAN SAMPLE. Record result in ppm cobalt.
15. Press **OFF** button to turn the colorimeter off or press **EXIT** button 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 – 1,000 color units

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

*WARNING: Reagents marked with * are considered hazardous substances. Material Safety Data Sheets (MSDS) are supplied for these reagents. For your safety, read label and accompanying MSDS before using.

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 to 2.0 ppm Copper

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

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

*WARNING: Reagents marked with * are considered hazardous substances. Material Data Safety Sheets (MSDS) are supplied for these reagents. For your safety, read label and accompanying MSDS before using.

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 into the water supply.

APPLICATION: Drinking, surface, and saline waters; domestic and industrial wastes.

RANGE: 0.00 – 6.00 ppm Copper

METHOD: Cupric 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 **ON** button until colorimeter turns on.
2. Press **ENTER** to start.
3. Press **ENTER** to select TESTING MENU.
4. Select ALL TESTS (or another sequence containing 11 Copper DDC) from TESTING MENU.
5. Scroll to and select 11 Copper DDC from menu.
6. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
7. Insert tube into chamber, close lid and select SCAN BLANK.
8. Remove tube from colorimeter and add 5 drops of *Copper 1 (6446). Cap and mix. Solution will turn yellow if copper is present.
9. Insert tube into chamber, close lid and select SCAN SAMPLE. Record result.
10. Press **OFF** button to turn colorimeter off or press **EXIT** button 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-SC

QUANTITY	CONTENTS	CODE
2 x 250 mL	*Cyanuric Acid Test Solution	*4856-K
1	Syringe, 5 mL	0807

*WARNING: Reagents marked with * are considered hazardous substances. Material Data Safety Sheets (MSDS) are supplied for these reagents. For your safety, read label and accompanying MSDS before using.

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

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 page 17).

PROCEDURE

1. Press and hold **ON** button until colorimeter turns on.
2. Press **ENTER** to start.
3. Press **ENTER** to select TESTING MENU.
4. Select ALL TESTS (or another sequence containing 12 Cyanuric) from TESTING MENU.
5. Scroll to and select 12 Cyanuric from menu.
6. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
7. Insert tube into chamber, close lid and select SCAN BLANK.
8. 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.
9. 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.
10. At end of 1 minute waiting period, mix thoroughly, insert tube into chamber, close lid and select SCAN SAMPLE. Record result.
11. Press **OFF** button to turn colorimeter off or press **EXIT** button to exit to a previous menu or make another menu selection.

NOTE: For the most accurate results, the sample and reagents should be at $25 \pm 4^{\circ}\text{C}$.

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

*WARNING: Reagents marked with a * are considered hazardous substances. Material Safety Data Sheets (MSDS) are supplied for these reagents. For your safety, read label and accompanying MSDS before using.

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.

RANGE: 0.0 – 11.0 ppm 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 reagent and the precipitate have 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.

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 **ON** button until colorimeter turns on.
2. Press **ENTER** to start.
3. Press **ENTER** to select TESTING MENU.
4. Select ALL TESTS (or another sequence containing 13 DO) from TESTING MENU.
5. Scroll to and select 13 DO from menu.
6. Rinse a clean tube (0290) with untreated sample water. Fill to the 10 mL line with sample. This tube is the BLANK.
7. Insert tube into chamber, close lid and select SCAN BLANK.
8. Fill a second tube (0290) to the 10 mL line with the treated "Fixed" sample. This tube is the SAMPLE.
9. Remove BLANK from colorimeter, insert SAMPLE tube into chamber, close lid and select SCAN SAMPLE. Record result.
10. Press **OFF** button to turn colorimeter off or press **EXIT** button to exit to a previous menu or make another menu selection.

FLUORIDE

SPADNS METHOD • CODE 3647-SC-01

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

*WARNING: Reagents marked with a * are considered hazardous substances. Material Safety Data Sheets (MSDS) are supplied for these reagents. For your safety, read label and accompanying MSDS before using.

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, page 1-27.

APPLICATION Drinking and surface waters; domestic and industrial waters.

RANGE: 0.00 – 2.00 ppm Fluoride

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.

SAMPLE HANDLING & PRESERVATION: Samples may be stored and refrigerated in plastic containers.

INTERFERENCES: The following substances produce a positive interference at the concentration given:

Chloride (Cl^-)	7000 mg/L
Phosphate (PO_4^{-3})	16 mg/L
Hexametaphosphate (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 **ON** button until colorimeter turns on.
2. Press **ENTER** to start.
3. Press **ENTER** to select TESTING MENU.
4. Select ALL TESTS (or another sequence containing 14 Fluoride) from TESTING MENU.
5. Scroll to and select 14 Fluoride from menu.
6. 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.
7. Use the 0.5 mL pipet (0353) to add 0.5 mL of *Sodium Arsenite Solution (4128). Cap and mix.
8. 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.)
9. Insert tube into chamber, close lid and select SCAN BLANK.
10. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample water. Repeat steps 7 and 8.
11. Insert tube into chamber, close lid and select SCAN SAMPLE. Record result.
12. Press **OFF** button to turn colorimeter off or press **EXIT** button to exit to a previous menu or make another menu selection.

HYDRAZINE

p-DIMETHYLAMINOBENZALDEHYDE METHOD CODE 3656-SC

QUANTITY	CONTENTS	CODE
2x60 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

*WARNING: Reagents marked with a * are considered hazardous substances. Material Safety Data Sheets (MSDS) are supplied for these reagents. For your safety, read label and accompanying MSDS before using.

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: 0.000 – 1.00 ppm Hydrazine

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 **ON** button until colorimeter turns on.
2. Press **ENTER** to start.
3. Press **ENTER** to select TESTING MENU.
4. Select ALL TESTS (or another sequence containing 15 Hydrazine) from TESTING MENU.
4. Scroll to and select 15 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 **OFF** button to turn colorimeter off or press **EXIT** button 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.

MOLYBDENUM - HIGH RANGE

THIOGLYCOLATE METHOD • CODE 3699-02-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 a * are considered hazardous substances. Material Safety Data Sheets (MSDS) are supplied for these reagents. For your safety read label and accompanying MSDS before using.

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

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.

PROCEDURE

1. Press and hold **ON** button until colorimeter turns on.
2. Press **ENTER** to start.
3. Press **ENTER** to select TESTING MENU.
4. Select ALL TESTS (or another sequence containing 16 Moly-HR) from TESTING MENU.
5. Scroll to and select 16 Moly-HR from menu.
6. Fill clean tube (0290) to 10 mL line with sample water.
7. Insert tube into chamber, close lid and select SCAN BLANK.
8. Remove tube from colorimeter. Use a 1.0 mL pipet (0372) to add 1.0 mL of *Mo Buffer (3997). Cap and mix.
9. Use a second 1.0 mL pipet (0372) to add 1.0 mL of *Molybdenum Oxidizing Reagent (6485). Cap and mix.
10. 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.
11. Insert tube into chamber, close lid and select SCAN SAMPLE. Record result.
12. Press **OFF** button to turn colorimeter off or press **EXIT** button 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

*WARNING: Reagents marked with a * are considered hazardous substances. Material Safety Data Sheets (MSDS) are supplied for these reagents. For your safety read label and accompanying MSDS before using.

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

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 **ON** button until colorimeter turns on.
10. Press **ENTER** to start.
11. Press **ENTER** to select TESTING MENU.
12. Select ALL TESTS (or another sequence containing 17 Nickel) from TESTING MENU.
13. Scroll to and select 17 Nickel from menu.
14. Insert the blank into chamber, close lid and select SCAN BLANK.
15. Insert test sample into chamber, close lid and select SCAN SAMPLE. Record result.
16. Press **OFF** button to turn colorimeter off or press **EXIT** button to exit to a previous menu or make another menu selection.

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 * are considered hazardous substances. Material Data Safety Sheets (MSDS) are supplied for these reagents. For your safety, read label and accompanying MSDS before using.

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 – 2.50 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 **ON** button until colorimeter turns on.
10. Press **ENTER** to start.
11. Press **ENTER** to select TESTING MENU.
12. Select ALL TESTS (or another sequence containing 18 Ozone-LR) from TESTING MENU.
13. Scroll to and select 18 Ozone-LR from menu.
14. Insert the **Reagent Blank** tube into chamber, close lid and select SCAN BLANK.
15. Insert reacted **Sample Tube** into chamber, close lid and select SCAN SAMPLE. Record result.
16. Press **OFF** button to turn colorimeter off or press **EXIT** button 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 **ON** button until colorimeter turns on.
10. Press **ENTER** to start.
11. Press **ENTER** to select TESTING MENU.
12. Select ALL TESTS (or another sequence containing 19 Ozone-HR) from TESTING MENU.
13. Scroll to and select 19 Ozone-HR from menu.
14. Insert the **Reagent Blank** tube into chamber, close lid and select SCAN BLANK.
15. Insert reacted **Sample Tube** into chamber, close lid and select SCAN SAMPLE. Record result.
16. Press **OFF** button to turn colorimeter off or press **EXIT** button 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 a * are considered hazardous substances. Material Safety Data Sheets (MSDS) are supplied for these reagents. For your safety read label and accompanying MSDS before using.

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

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 **ON** button until colorimeter turns on.
2. Press **ENTER** to start.
3. Press **ENTER** to select TESTING MENU.
4. Select ALL TESTS (or another sequence containing 20 Phosphate L) from TESTING MENU.
5. Scroll to and select 20 Phosphate L from menu.
6. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
7. Insert tube into chamber, close lid and select SCAN BLANK.
8. Remove tube from colorimeter. Use 1.0 mL pipet (0354) to add 1.0 mL of *Phosphate Acid Reagent (V-6282). Cap and mix.
9. Use the 0.1 g spoon (0699) to add one measure of *Phosphate Reducing Reagent (V-6283). Cap and shake until powder dissolves. Wait 5 minutes for full color development. Solution will turn blue if phosphates are present.
10. At end of 5 minute waiting period, mix, insert tube into chamber, close lid and select SCAN SAMPLE. Record result.
11. Press **OFF** button to turn colorimeter off or press **EXIT** button to exit to a previous menu or make another menu selection.

PHOSPHATE - HIGH RANGE

VANADOMOLYBDOPHOSPHORIC ACID METHOD CODE 3655-SC

QUANTITY	CONTENTS	CODE
60 mL	*VM Phosphate Reagent	*4410-H
1	Pipet, 1.0 mL, plastic	0354

*WARNING: Reagents marked with a * are considered hazardous substances. Material Safety Data Sheets (MSDS) are supplied for these reagents. For your safety, read label and accompanying MSDS before using.

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

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 **ON** button until colorimeter turns on.
2. Press **ENTER** to start.
3. Press **ENTER** to select TESTING MENU.
4. Select ALL TESTS (or another sequence containing 21 Phosphate H) from TESTING MENU.
5. Scroll to and select 21 Phosphate H from menu.
6. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
7. Insert tube into chamber, close lid and select SCAN BLANK.
8. 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.
9. After 5 minute waiting period, mix, insert tube into chamber, close lid and select SCAN SAMPLE. Record result.
10. Press **OFF** button to turn colorimeter off or press **EXIT** button 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

*WARNING: Reagents marked with a * are considered hazardous substances. Material Safety Data Sheets (MSDS) are supplied for these reagents. For your safety read label and accompanying MSDS before using.

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

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 page 17).

PROCEDURE

1. Press and hold **ON** button until colorimeter turns on.
2. Press **ENTER** to start.
3. Press **ENTER** to select TESTING MENU.
4. Select ALL TESTS (or another sequence containing 22 Potassium) from TESTING MENU.
5. Scroll to and select 22 Potassium from menu.
6. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
7. Insert tube into chamber, close lid and select SCAN BLANK.
8. Remove tube from colorimeter. Add 4 drops of *Sodium Hydroxide, 1.0N (4004WT). Cap and mix.
9. 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.
10. 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.
11. Press **OFF** button to turn colorimeter off or press **EXIT** button 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 $25 \pm 4^{\circ}\text{C}$.

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

*WARNING: Reagents marked with a * are considered hazardous substances. Material Safety Data Sheets (MSDS) are supplied for these reagents. For your safety read label and accompanying MSDS before using.

Silicon dioxide, SiO₂, 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

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 **ON** button until colorimeter turns on.
2. Press **ENTER** to start.
3. Press **ENTER** to select TESTING MENU.
4. Select ALL TESTS (or another sequence containing 23 Silica Lo) from TESTING MENU.
5. Scroll to and select 23 Silica Lo from menu.
6. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
7. Insert tube into chamber, close lid and select SCAN BLANK. (See Note)
8. Remove tube from colorimeter. Add 6 drops *Silica Reagent #1 (V-4466). Cap and invert to mix.
9. Add 12 drops of *Silica Reagent #2 (V-4467). Cap and mix. Wait 5 minutes.
10. Add 8 drops of *Silica Reagent #3 (V-4468). Cap and mix. Wait 2 minutes.
11. 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.
12. At end of 5 minute waiting period, mix, insert tube into chamber, close lid and select SCAN SAMPLE. Record result.
13. Press **OFF** button to turn colorimeter off or press **EXIT** button 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 a * are considered hazardous substances. Material Safety Data Sheets (MSDS) are supplied for these reagents. For your safety read label and accompanying MSDS before using.

Silicon dioxide, SiO₂, 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

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 **ON** button until colorimeter turns on.
2. Press **ENTER** to start.
3. Press **ENTER** to select TESTING MENU.
4. Select ALL TESTS (or another sequence containing 24 Silica Hi) from TESTING MENU.
5. Scroll to and select 24 Silica Hi from menu.
6. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
7. Insert tube into chamber, close lid and select SCAN BLANK.
8. Remove tube from colorimeter. Add 6 drops *Silica Reagent #1 (V-4466). Cap and invert to mix.
9. Add 12 drops of *Silica Reagent #2 (V-4467). Cap and mix. Wait 5 minutes.
10. At end of 5 minute waiting period, add 8 drops of *Silica Reagent #3 (V-4468). Cap and mix.
11. Insert tube into chamber, close lid and select SCAN SAMPLE. Record result.
12. Press **OFF** button to turn colorimeter off or press **EXIT** button 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 a * are considered hazardous substances. Material Safety Data Sheets (MSDS) are supplied for these reagents. For your safety read label and accompanying MSDS before using.

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

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 17).

PROCEDURE

1. Press and hold **ON** button until colorimeter turns on.
2. Press **ENTER** to start.
3. Press **ENTER** to select TESTING MENU.
4. Select ALL TESTS (or another sequence containing 25 Sulfate-HR) from TESTING MENU.
5. Scroll to and select 25 Sulfate-HR from menu.
6. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
7. Insert tube into chamber, close lid and select SCAN BLANK.
8. 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.
9. Mix tube again. Insert tube into chamber, close lid and select SCAN SAMPLE. Record result.
10. Press **OFF** button to turn colorimeter off or press **EXIT** button to exit to a previous menu or make another menu selection.

NOTES:

- 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 $25\pm 4^{\circ}\text{C}$.

SULFIDE - LOW RANGE

METHYLENE BLUE METHOD • CODE 3654-01-SC

QUANTITY	CONTENTS	CODE
2 X 30 mL	*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 a * are considered hazardous substances. Material Safety Data Sheets (MSDS) are supplied for these reagents. For your safety, read label and accompanying MSDS before using.

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

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 **ON** button until colorimeter turns on.
2. Press **ENTER** to start.
3. Press **ENTER** to select TESTING MENU.
4. Select ALL TESTS (or another sequence containing 26 Sulfide-LR) from TESTING MENU.
5. Scroll to and select 26 Sulfide-LR from menu.
6. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
7. Insert tube into chamber, close lid and select SCAN BLANK.
8. 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.
9. Add 6 drops of Sulfide Reagent B (V-4459). Cap and mix. Wait 1 minute. Solution will turn blue if sulfides are present.
10. 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.
11. Insert tube into chamber, close lid and select SCAN SAMPLE. Record result.
12. Press **OFF** button to turn colorimeter off or press **EXIT** button to exit to a previous menu or make another menu selection.

TANNIN

TUNGSTO-MOLYBDOPHOSPHORIC ACID METHOD CODE 3666-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 a * are considered hazardous substances. Material Safety Data Sheets (MSDS) are supplied for these reagents. For your safety read label and accompanying MSDS before using.

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: 0.00 – 10.00 ppm Tannic Acid

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 **ON** button until colorimeter turns on.
2. Press **ENTER** to start.
3. Press **ENTER** to select TESTING MENU.
4. Select ALL TESTS (or another sequence containing 27 Tannin) from TESTING MENU.
5. Scroll to and select 27 Tannin from menu.
6. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
7. Insert tube into chamber, close lid and select SCAN BLANK.
8. Remove tube from colorimeter. Use the plain pipet (0352) to add 4 drops of *Tannin Reagent #1 (7833). Cap and mix.
9. 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.
10. At end of 30 minute waiting period, mix, insert tube into chamber, close lid and select SCAN SAMPLE. Record result.
11. Press **OFF** button to turn colorimeter off or press **EXIT** button 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 $20 \pm 2^{\circ}\text{C}$.

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 – 400 FTUs

METHOD: Absorptimetric

SAMPLE HANDLING & PRESERVATION: Measure sample as soon as possible after collection.

INTERFERENCES: Check for stray light interference (p. 17).

PROCEDURE

1. Press and hold **ON** button until colorimeter turns on.
2. Press **ENTER** to start.
3. Press **ENTER** to select TESTING MENU.
4. Select ALL TESTS (or another sequence containing 28 Turbidity) from TESTING MENU.
5. Scroll to and select 28 Turbidity from menu.
6. Rinse a clean tube (0290) with deionized water (turbidity free). Fill to the 10 mL line with deionized water.
7. Insert tube into chamber, close lid and select SCAN BLANK.
8. 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.
9. 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.
10. Press **OFF** button to turn colorimeter off or press **EXIT** button to exit to a previous menu or make another menu selection.

NOTE: For the most accurate results, the sample should be at $25 \pm 4^\circ\text{C}$.

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, with 1 mL 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 a * are considered hazardous substances. Material Safety Data Sheets (MSDS) are supplied for these reagents. For your safety read label and accompanying MSDS before using.

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

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	CrO ₄ (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 **ON** button until colorimeter turns on.
2. Press **ENTER** to start.
3. Press **ENTER** to select TESTING MENU.
4. Select ALL TESTS (or another sequence containing 29 Zinc-LR) from TESTING MENU.
5. Scroll to and select 29 Zinc-LR from menu.
6. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
7. Insert tube into chamber, close lid and select SCAN BLANK. (See Note)
8. 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.
9. Add 3 drops of *Sodium Cyanide, 10% (6565). Cap and mix.
10. Use the 1 mL pipet assembly to add 1 mL of "Dilute Zinc Indicator Solution". Cap and mix.
11. Use a second plain pipet (0352) to add 4 drops of *Formaldehyde Solution, 37% (5128). Cap and mix by inverting 15 times.
12. Insert tube into chamber, close lid and select SCAN SAMPLE. Record result.
13. Press **OFF** button to turn colorimeter off or press **EXIT** button 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.



APPENDIX



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.

pH	10°C		15°C		20°C		25°C	
	FW ¹	SW ²	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

¹Freshwater data from Trussel (1972).

²Seawater 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