SMART Spectro

Spectrophotometer

TEST INSTRUCTIONS

LaMotte

v2.0 • 03.05
2000-MN

SPECTROPHOTOMETER

REAGENT SYSTEMS LIST

LaMotte Company continuously updates the list of pre-programmed tests as the calibrations become available. Call LaMotte Technical Services at 1-800-344-3100 (410-778-3100 outside the USA) or e-mail at tech@lamotte.com for a current list of available calibrations.

Test Factor	*Test #*	*Range()*	*Test Method (# of Reagents)*	*# of Tests*
Alkalinity-UDV	(2)	0-200	UDose Vials (1)	50
Aluminum	(1)	0.00-0.30	Eriochrome Cyanine R (4)	50
Ammonia Nitrogen-Low Range, Fresh Water	(3)	0.00-1.00	Salicylate (3)	25
Ammonia Nitrogen-Low Range, Salt Water	(4)	0.00-1.00	Salicylate (3)	25
Ammonia Nitrogen-High Range	(5)	0.00-4.00	Nesslerization (2)	50
Biguanide	(7)	0-70	Colorimetric (1)	50
Boron	(8)	0.00-0.80	Azomethine-H (2)	25
Bromine-Low Range	(9)	0.00-9.00	(3)	100
Bromine-UDV	(11)	0.0-22.0	DPD (1)	
Cadmium	(12)	0.00-1.00	PAN (4)	50
Ca & Mg Hardness-UDV	(13)	10-500	Unit Dose Vials (1)	50
Carbohydrazide	(14)	0.000-0.900	Iron Reduction (3)	100
Chlorine	(15)	0.00-4.00	DPD (3)	100
Chlorine-Free-UDV	(16)	0.00-10.00	DPD (1)	50
Chlorine-Liquid DPD	(17)	0.00-4.00	DPD (3)	144
Chlorine-Total	(18)	0.00-10.00	DPD (1)	50
Chlorine Dioxide	(20)	0.00-7.00	DPD (3)	100
Chloride-TesTab	(21)	0.0-30.0	Argentometric (1)	50
Chromium	(22)	0.00-1.00	Diphenylcarbohydrazide (1) or (5)	100
Chromium-TesTab	(23)	0.00-1.00	Diphenylcarbohydrazide (1)	50
Cobalt	(24)	0.00-2.00	PAN (3)	50
COD-Low Range	(25)	5-150	Digestion (1)	25
COD-Standard Range	(26)	0-1500	Digestion (1)	25
COD-High Range	(27)	0-15000	Digestion (1)	25
Color	(28)	0-1000	Platinum Cobalt (0)	∞
Copper-BCA-Low Range	(29)	0.00-3.50	Bicinchoninic Acid (1)	50
Copper-Cuprizone	(31)	0.00-2.00	Cuprizone (2)	50
Copper-DDC	(32)	0.00-6.00	Diethyldithiocarbamate (1)	50
Copper-UDV	(33)	0.0-4.0	Bicinchoninic Acid (1)	50
Cyanide	(35)	0.00-0.500	Pyridine-Barbituric Acid (5)	50
Cyanuric Acid	(36)	5-200	Melamine (1)	100
Cyanuric Acid-UDV	(37)	5-150	Melamine (1)	50
Diethykhydroxylamine	(38)	0.000-0.700	Iron Reduction (3)	100
Dissolved Oxygen	(39)	0.0-12.0	Winkler Colorimetric (3)	100
Erythrobic Acid	(40)	0.00-3.00	Iron Reduction (3)	100
Fluoride	(41)	0.00-2.00	SPADNS (2)	50
Hardness, TesTab	(44)	0-350	Phthalein Purple (1)	50
Hydrazine	(45)	0.00-1.00	Dimethylaminobenzaldehyde (2)	25

Hydrogen Peroxide-Low Range	(46)	0.00-1.50	DPD (2)	100
Hydrogen Peroxide-High Range	(47)	0-60	DPD (2)	50
Hydrogen Peroxide-Shock	(48)	0-225	DPD (2)	50
Hydroquinone	(49)	0.00-1.80	Iron Reduction (3)	100
Iodine	(50)	0.00-14.00	DPD (2)	100
Iron-Bipyridyl	(51)	0.00-6.00	Bipyridyl (2)	50
Iron-UDV	(52)	0.00-10.00	Bipyridyl (1)	50
Iron-Phenanthroline	(53)	0.00-4.50	1,10 Phenanthroline (2)	50
Lead	(54)	0.00-5.00	PAR (5)	50
Manganese-Low Range	(55)	0.00-0.70	PAN (3)	50
Manganese-High Range	(56)	0.0-15.0	Periodate (2)	50
Mercury	(57)	0.00-1.50	TML (3)	50
Methylethylketoxime	(58)	0.00-3.00	Iron Reduction (3)	100
Molybdenum-High Range	(61)	0.0-15.0	Thioglycolate (3)	50
Nickel	(63)	0.00-8.00	Dimethylglyoxime (6)	50
Nitrate Nitrogen-Low Range	(64)	0.00-3.00	Cadmium Reduction (2)	20
Nitrate-TesTab	(66)	0-60	Zinc Reduction (1)	50
Nitrite Nitrogen-Low Range	(67)	0.00-0.80	Diazotization (2)	20
Nitrite-TesTab	(69)	0.00-1.25	Diazotization (1)	50
Nitrogen, Total	(62)	0-25	Chromotropic Acid/Digestion (6)	50
Oxygen Scavengers (listed under individual tests)				
Ozone-Low Range	(71)	0.00-0.40	Indigo (3)	100
Ozone-High Range	(72)	0.00-2.50	Indigo (3)	25
pH-Chlorophenol Red	(74)	5.0-7.0	Chlorophenol Red (1)	100
pH-Phenol Red	(75)	6.6-8.4	Phenol Red (1)	100
pH-Thymol Blue	(76)	8.0-9.5	Thymol Blue (1)	100
Phenol	(77)	0.00-6.00	Aminoantipyrine (3)	50
Phosphate-Low Range	(78)	0.00-3.00	Ascorbic Acid Reduction (2)	50
Phosphate-High Range	(79)	0.0-70.0	Vanodomolybdphosphoric Acid (1)	50
Phosphorus, Total-Low Range	(82)	0.00-3.50	Ascorbic Acid/Digestion (5)	50
Phosphorus, Total-High Range	(83)	0.0-100.0	Molybdovanadate/Digestion (5)	50
Potassium	(81)	0.0-10.0	Tetraphenylboron (2)	100
Silica-Low Range	(85)	0.00-2.50	Heteropoly Blue (4)	50
Silica-High Range	(86)	0-50	Silicomolybdate (3)	50
Sulfate-High Range	(89)	6-100	Barium Chloride (1)	50
Sulfide-Low Range	(90)	0.00-1.00	Methylene Blue (3)	50
Surfactants	(94)	0.5-8.0	Bromphenol Blue (3)	50
Tannin	(96)	0.0-10.0	Tungsto-molybdophosphoric Acid (2)	50
Turbidity	(98)	0-400 FTU	Absorption (0)	∞
Zinc-Low Range	(99)	0.00-3.00	Zincon (6)	50

ALKALINITY–UDV

METHOD–UNIT DOSE VIALS • CODE 4318-H

QUANTITY	CONTENTS	CODE
1	Alkalinity Unit Dose Vials, 10 pouches	4318-H

Equipment needed but not supplied:

STANDARD ACCESSORY PACKAGE • CODE 1961

1	Package of 3 Vials (empty)	0156
1	Syringe, 6 mL, plastic	1184
1	Foil Storage Bag	9467

Or:

ADVANCED ACCESSORY PACKAGE • CODE 1962

1	Pipettor	30528
1	Pipet Tip (0-5 mL)	30695
1	Cuvette Rack	31695
1	Package of 3 Vials (empty)	0156
1	Foil Storage Bag	9467

*WARNING: Reagents marked with an * are considered hazardous substances. To view or print a Material Safety Data Sheet (MSDS) for these reagents see MSDS CD or our web site. To obtain a printed copy, contact us by e-mail, phone or fax.

Alkalinity is a measure of the acid-neutralizing capacity of water that enables it to resist abrupt changes in pH. It is the sum of all titratable bases. Alkalinity is significant in maintaining proper pH levels in natural water; water used for irrigation, swimming pools, industrial processes and wastewater treatment processes.

The presence of buffering materials in natural waters helps to neutralize acids as they are added to, or created in, the water ecosystem. A Total Alkalinity of 100 to 200 ppm will stabilize the pH level in a stream. In swimming pools, total alkalinity is commonly known as a pH stabilizer because, when the alkalinity is at a proper level, a consistent pH level can be maintained while treatment chemicals or fresh make-up water is added. In industrial situations, alkalinity is an important factor in preventing fluctuating pH levels that can damage equipment and corrode pipes.

APPLICATION: Drinking and surface water and swimming pool water

RANGE: 0–200 ppm as $CaCO_3$ SMART Spectro

METHOD: The sample is added to a buffered indicator reagent. The color that develops, ranging from yellow to blue, will indicate the amount of alkalinity in the sample.

SAMPLE HANDLING & PRESERVATION: Samples should be analyzed as soon as possible after collection. Sample may be refrigerated for 24 hours.

INTERFERENCES: Quats and poly quats at high concentrations will interfere.

PROCEDURE

Use 10 mm square cell adapter

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select PROGRAMMED TESTS.
3. Scroll to and select ALL TESTS (or another sequence containing 2 Alk-UDV) from TESTING MENU.
4. Scroll to and select 2 Alk-UDV from menu.
5. Rinse a clean vial (0156) with sample water.
6. Use the syringe (1184) to add 3 mL of sample to the vial.
7. Insert the vial into chamber, close lid and select SCAN BLANK.
8. Remove vial from Spectro.
9. Use the syringe (1184) to add 3 mL of sample to a Alk UDV vial (4318).
10. Wait 2 minutes.
11. Invert vial 3 times to mix.

    ☑NOTE: If powder residue remains in the bottom of the vial after inverting or air bubbles form, invert once more and tap bottom of vial sharply once or twice to dislodge powder and bubbles. Mix.
12. Insert tube into chamber, close lid and select SCAN SAMPLE. Record result.
13. Press **OFF** button to turn the spectrophotometer 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.

UDVs from opened pouches should be used promptly. Store unused vials from opened pouches in the Foil Storage Bag (9467) to extend the shelf life of the reagent. Generally, UDVs stored in the bag should be used within 10 days if the humidity is less than 50% and within 5 days if humidity is greater than 50%. The Foil Storage Bag contains a dessicant pack with indicator. When the indicator in the window turns from blue to pink, the bag should be replaced.

ALUMINUM

ERIOCHROME CYANINE R METHOD • CODE 364I-SC

QUANTITY	CONTENTS	CODE
5 g	*Aluminum Inhibitor Reagent	*7865-C
2 x 120 mL	*Aluminum Buffer Reagent	*7866-J
120 mL	Aluminum Indicator Reagent	7867-J
15 mL	Aluminum Complexing Reagent	7868-E
1	Spoon, 0.1 g, plastic	0699
1	Spoon, 0.05 g, plastic	0696
2	Pipets, 1.0 mL, plastic	0354
1	Test Tube, glass, 5 mL w/cap	0230

*WARNING: Reagents marked with an * are considered hazardous substances. To view or print a Material Safety Data Sheet (MSDS) for these reagents see MSDS CD or our web site. To obtain a printed copy, contact us by e-mail, phone or fax.

Aluminum is the third most common element in the earth's crust, which accounts for its wide appearance in many water supplies. Aluminum exists in water as soluble salts, colloidal compounds, and insoluble compounds. In wastewater that has been treated by alum coagulation it will appear in one or more of the above forms. Properly treated drinking water should have an aluminum concentration below 0.05 mg/L.

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

RANGE: 0.00–0.30 ppm Aluminum

METHOD: Aluminum ions buffered to a pH of 6.0 react with Eriochrome Cyanine R dye to produce a pink to red complex in proportion to the concentration.

SAMPLE HANDLING & PRESERVATION: Collect sample in acid washed glass or plastic bottle. Analyze as soon as possible.

INTERFERENCES: Fluoride and polyphosphate will interfere. Interference from iron and manganese is eliminated by the addition of an inhibitor.

PROCEDURE

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select `PROGRAMMED TESTS`.
3. Scroll to and select `ALL TESTS` (or another sequence containing `1 Aluminum`).
4. Scroll to and select `1 Aluminum` from menu.
5. Rinse a clean Spectro tube (0290) with sample water. Fill to the 10 mL line with sample.
6. Insert tube into Spectro chamber and select `SCAN BLANK`.
7. Rinse a clean test tube (0230) with sample water. Fill to the 5 mL line with sample.
8. Remove tube from Spectro. Empty sample from Spectro tube (0290).
9. Add 5 mL sample from test tube (0230) to empty Spectro tube (0290).
10. Use the 0.05 g spoon (0696) to add one measure of *Aluminum Inhibitor Reagent (7865). Cap and mix.
11. Use a 1.0 mL pipet (0354) to add 2 mL of *Aluminum Buffer Reagent (7866). Cap and mix.
12. Use a second 1.0 mL pipet (0354) to add 1 mL of Aluminum Indicator Reagent (7867). Cap and mix contents. Wait 5 minutes for maximum color development.
13. At end of 5 minute waiting period, mix, insert tube into chamber, close lid and select `SCAN SAMPLE`. Record result.
14. Press **OFF** button to turn the spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

☑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. Add 5 drops of Aluminum Complexing Reagent (7868). 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–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

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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

Use universal sample holder.

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

CALCULATIONS:

To express results as Unionized Ammonia (NH_3):

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

To express results as Ionized Ammonia (NH_4):

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

☑NOTES: 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.

To determine the percentage of Ammonia-Nitrogen that is unionized and ionized, consult the Appendix.

PROCEDURE–SALT WATER

Use universal sample holder.

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

CALCULATIONS:

To express results as Unionized Ammonia (NH_3):

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

To express results as Ionized Ammonia (NH_4):

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

☑ NOTES: 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.

To determine the percentage of Ammonia-Nitrogen that is unionized and ionized, consult the Appendix.

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

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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

Use universal sample holder.

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

CALCULATIONS:

To express results as Unionized Ammonia (NH_3):

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

To express results as Ionized Ammonia (NH_4):

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

☑NOTES: 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.

To determine the percentage of Ammonia-Nitrogen that is unionized and ionized, consult the Appendix.

CHLORINE–BROMINE–IODINE

DPD METHOD • CODE 3643-SC

QUANTITY	CONTENTS	CODE
100	*Chlorine DPD #1 Instrument Grade Tablets	*6903-J
100	*Chlorine DPD #3 Instrument Grade Tablets	*6197-J
15 mL	Glycine Solution	6811-E
1	Tablet Crusher	0175

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All water for cities and communities must be sanitized; even waters that come from clean sources, protected watersheds, reservoirs, and deep wells, are commonly sanitized to assure safety. Chlorine is the most commonly used sanitizer for several reasons: it is effective against a wide range of microorganisms, the cost is low, and the methods of applying it have been well developed. If an adequate concentration of chlorine is present in the water for a few minutes, disease producing bacteria will be destroyed. A number of conditions affect the sanitizing action of chlorine. In municipal systems these can be controlled so that if chlorine is detectable, it can be assumed that bacteria have been killed. The factors that influence the rate of kill are temperature, pH, presence of other materials that react with chlorine, time, and the concentrations of the various chlorine combinations that are formed in the water with ammonia and other substances that react with chlorine.

The fact that chlorine can be easily detected and measured makes chlorine a favorite water sanitizer of those concerned with the public safety of water supplies. Chlorine concentrations in the range of 0.1 to 0.4 parts per million are usually maintained in municipal supplies.

Chlorine can be added in the form of chlorine gas, liquid sodium hypochlorite (bleach), granular calcium hypochlorite or as organic chlorine compounds. Chlorine is not present in natural water supplies; if it is present it is the result of chlorination of a water supply or of chlorinated compounds being discharged as waste from industrial operations. The presence of chlorine in concentrations above 0.5 parts per million should be considered evidence of pollution from chlorine treated effluents or from a process in which high concentrations of chlorine are used.

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

RANGE: 0.00–4.00 ppm Chlorine

METHOD: In the absence of iodide, free available chlorine reacts instantly with DPD to produce a red color. Subsequent addition of potassium iodide evokes a rapid color response from the combined forms of chlorine (chloramines).

SAMPLE HANDLING & PRESERVATION: Chlorine in aqueous solutions is not stable, and the chlorine content of samples or solutions, particularly weak solutions, will rapidly decrease. Exposure to sunlight or agitation will accelerate the reduction of chlorine present in such solutions. For best results, start analysis immediately after sampling. Samples to be analyzed for chlorine cannot be preserved or stored.

INTERFERENCE: The only interfering substance likely to be encountered in water is oxidized manganese. The extent of this interference can be determined by treating a sample with sodium arsenite to destroy the chlorine present so that the degree of interference can be measured.

Iodine and bromine can give a positive interference, but these are not normally present unless they have been added as sanitizers.

PROCEDURE–FREE CHLORINE

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select `PROGRAMMED TESTS`.
3. Scroll to and select `ALL TESTS` (or another sequence containing `15 Chlorine`) from `TESTING MENU`.
4. Scroll to and select `15 Chlorine` 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 Spectro and pour off all but a sufficient amount of sample water to cover a tablet. Add one *Chlorine DPD #1 Instrument Grade Tablet (6903). Crush tablet with a tablet crusher (0175), then add sample water until tube is filled to 10 mL line. Cap tube and shake until tablet has dissolved. Solution will turn pink if free chlorine is present. Wait 15 seconds, but no longer than 30 seconds. Mix.
8. Insert tube into chamber, close lid and select `SCAN SAMPLE`.

PROCEDURE–COMBINED CHLORINE

Use universal sample holder.

9. Add one *Chlorine DPD #3 Instrument Grade Tablet (6197) to sample from Step 8 above. Crush tablet with tablet crusher (0175). Cap tube and shake until tablet dissolves. An increase in color represents combined chlorine.

   ☑NOTE: For wastewater samples, *Standard Methods for the Examination of Water and Wastewater* recommends waiting 2 minutes for full color development.
10. Insert sample into chamber, close lid and select `SCAN SAMPLE`. Record result as Total Chlorine.
11. Subtract free chlorine reading from total chlorine reading to obtain concentration of combined chlorine.
12. Press the **OFF** button to turn off the spectrophotometer or press the **EXIT** button to exit to a previous menu or make another menu selection.

BROMINE

Like chlorine, bromine is an effective germicidal agent employed in drinking water treatment, pool and spa water sanitation, food service sanitation, and other public health applications.

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

RANGE: 0.00–9.00 ppm Bromine

METHOD: In buffered sample bromine reacts with diethyl-p-phenylene diamine (DPD) to produce a pink-red color in proportion to the concentration of bromine present.

SAMPLE HANDLING & PRESERVATION: Bromine in aqueous solutions is not stable, and the bromine content of samples or solutions, particularly weak solutions, will rapidly decrease. Exposure to sunlight or agitation will accelerate the reduction of bromine present in such solutions. For best results start analysis immediately after sampling. Samples to be analyzed for bromine cannot be preserved or stored.

INTERFERENCE: The only interfering substance likely to be encountered in water is oxidized manganese. The extent of this interference can be determined by treating a sample with sodium arsenite to destroy the bromine present so that the degree of interference can be estimated.

Iodine and chlorine can also interfere, but these are not normally present unless they have been added as sanitizers.

PROCEDURE A: BROMINE (NO CHLORINE)

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select `PROGRAMMED TESTS`.
3. Scroll to and select `ALL TESTS` (or another sequence containing `9 Bromine-LR`) from `TESTING MENU`.
4. Scroll to and select `9 Bromine-LR` from menu.
5. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
6. Insert tube into chamber, close lid and select `SCAN BLANK`.
7. Remove tube from Spectro. Pour out all but a sufficient amount of sample water to cover a tablet. Add one *Chlorine DPD #1 Instrument Grade Tablet (6903). Crush tablet with crusher (0175), then add sample water until tube is filled to 10 mL line. Cap tube and shake until tablet is dissolved. Solution will turn pink if bromine is present. Wait 15 seconds. Mix.
8. Insert tube into chamber, close lid and select `SCAN SAMPLE`.
9. Press **OFF** button to turn spectrophotometer off or press the **EXIT** button to exit to a previous menu or make another menu selection.

PROCEDURE B: BROMINE IN THE PRESENCE OF CHLORINE

Use universal sample holder.

1. Press **USE** button to turn on colorimeter.
2. Scroll to and select `ALL TESTS` (or another sequence containing `9 Bromine-LR`) from `TESTING MENU`.
3. Scroll to and select `9 Bromine-LR` from menu.
4. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
5. Insert tube into chamber close lid and select `SCAN BLANK`.
6. Rinse a second clean tube (0290) with sample water. Fill to the 10 mL line with sample. Add 5 drops of Glycine Solution (6811). Cap and mix.
7. Remove blank from Spectro. Pour out all of the sample water. To this tube add just enough of Glycine treated sample (Step 6) to cover a tablet. Add one *Chlorine DPD#1 Instrument Grade Tablet (6903). Crush tablet with a tablet crusher (0175). Add all remaining Glycine-treated sample. Cap tube and shake until tablet dissolves. Solution will turn pink if bromine is present. Wait 15 seconds. Mix.
8. Insert tube into chamber, close lid and select `SCAN SAMPLE`.
9. Press **OFF** button to exit to previous menu or make another menu selection.

PROCEDURE C: FREE AVAILABLE, TOTAL AVAILABLE & COMBINED CHLORINE IN THE PRESENCE OF BROMINE

1. Perform the test for free and combined chlorine as previously described.
2. Perform the test for bromine in the presence of chlorine.
3. Calculations:

   Residual Bromine (ppm) =
   Reading BR

   Free Chlorine in the Presence of Bromine =
   Free Chlorine–0.45 (Reading BR)

   Total Chlorine in the Presence of Bromine =
   Total Chlorine–0.45 (Reading BR)

   Combined Chlorine in the Presence of Bromine =
   Total Chlorine–Free Chlorine

☑NOTE: Combined chlorine is not affected by the presence of bromine, so the calculation is the same as when only chlorine is present.

IODINE

Like chlorine and bromine, iodine is an effective germicidal agent employed in drinking water treatment, pool and spa water sanitation, food service sanitation, and other public health applications.

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

RANGE: 0.00–14.00 ppm Iodine

METHOD: In a buffered sample iodine reacts with diethyl-p-phenylene-diamine (DPD) to produce a pink-red color in proportion to the concentration of iodine present.

SAMPLE HANDLING & PRESERVATION: Iodine in aqueous solutions is not stable, and the iodine content of samples or solutions, particularly weak solutions, will rapidly decrease. Exposure to sunlight or agitation will accelerate the reduction of iodine present in such solutions. For best results start analysis immediately after sampling. Samples to be analyzed for iodine cannot be preserved or stored.

INTERFERENCE: The only interfering substance likely to be encountered in water is oxidized manganese. The extent of this interference can be determined by treating a sample with sodium arsenite to destroy the iodine present so that the degree of interference can be measured.

Chlorine and bromine can give a positive interference, but these are not normally present unless they have been added as sanitizers.

PROCEDURE

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select `PROGRAMMED TESTS`.
3. Scroll to and select `ALL TESTS` (or another sequence containing `50 Iodine`) from `TESTING MENU`.
4. Scroll to and select `50 Iodine` from menu.
5. Rinse a clean tube (0290) with sample water. Fill tube to the 10 mL line with sample.
6. Insert tube into chamber, close lid and select `SCAN BLANK`.
7. Remove tube from Spectro. Pour off all but a sufficient amount of sample water to cover a tablet. Add one *DPD #1 Tablet Instrument Grade (6903). Crush tablet with tablet crusher (0175). Add sample water until tube is filled to 10 mL line. Cap and shake until tablet dissolves. Solution will turn pink if iodine is present. Wait 15 seconds. Mix.
8. Insert tube into chamber, close lid and select `SCAN SAMPLE`. Record result.
9. Press **OFF** button to turn spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

BIGUANIDE

COLORIMETRIC METHOD • CODE 4044

QUANTITY	CONTENTS	CODE
2 X 60 mL	Biguanide Indicator	3994-H
1	Pipet, plastic, 1.0 mL	0354

Biguanide is a non-chlorine, non-bromine chemical sanitizer. It is more stable than chlorine or bromine and has little chemical odor. Biquanide is an effective bacteriacide but, unlike chlorine and bromine, it does not destroy organic contaminants. Therefore, hydrogen peroxide is added to biguanide pools on a regular basis to eliminate organic contaminants. The optimum recommended level of biguanide is 30 to 50 ppm.

APPLICATION: Swimming pools

RANGE: 0–70 ppm

METHOD: Biguanide complexes with the proprietary indicator to produce a colored solution. The color ranges from yellow through green to blue depending on the biguanide concentration.

SAMPLE HANDLING & PRESERVATION: Samples should be analyzed as soon as possible.

INTERFERENCES: The only interfering substances that are likely to be encountered in pool water are oxidized manganese and oxidizing agents, such as chlorine, bromine and ozone.

PROCEDURE

Use universal sample holder

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select `PROGRAMMED TESTS`.
3. Select `ALL TESTS` (or another sequence containing `7 Biguanide` from `TESTING MENU`.
4. Scroll to and select `7 Biguanide` from menu.
5. Rinse a tube (0290) with sample water. Fill to 10 mL with sample.
6. Insert the tube into chamber, close lid and select `SCAN BLANK`.
7. Remove the tube from colorimeter.
8. Use the 1.0 mL pipet (0354) to add 2.0 mL of Biguanide Indicator (3994). Cap and invert three times to mix.
9. Wait 1 minute.
10. Insert the tube into chamber. Close lid.
11. Select `SCAN SAMPLE`. Record result in ppm Biguanide
12. Press **OFF** button to turn the spectrophotometer 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.

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
1	Dark Storage Chamber, brown	0108

*WARNING: Reagents marked with an * are considered hazardous substances. To view or print a Material Safety Data Sheet (MSDS) for these reagents see MSDS CD or our web site. To obtain a printed copy, contact us by e-mail, phone or fax.

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

APPLICATION: Surface and saline waters, hydroponic solutions, industrial waste, swimming pools.

RANGE: 0.00–0.80 ppm Boron

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

Use universal sample holder

1. This test requires a Reagent Blank. Rinse a tube (0290) with clear, colorless, boron free water. Fill to 10 mL line with clear, colorless, boron free water.
2. Use the 1.0 mL pipet (0354) to add 2 mL of *Boron Buffer (4869). Cap and mix.
3. Use the 0.15 g spoon (0727) to add one level measure of *Boron Indicator Powder (4870). Press full spoon against side of jar to compress powder. Scrape off excess powder on inside neck of bottle. Tap excess off spoon handle.
4. Cap and shake vigorously for 30 seconds.
5. Insert the tube into meter chamber. Close lid.
6. Start a timer set for 30 minutes. Do not open the lid during the waiting time. The reaction is photosensitive.
7. Rinse a clean tube (0290) with Sample Water. Fill to the 10 mL line with sample water. Repeat steps 2-4.
8. Insert the tube into the Dark Storage Chamber (29849). Close top.
9. Start a second timer set for 30 minutes. Do not open the chamber during the waiting time. The reaction is photosensitive.
10. When 2 minutes remain on the first timer (Reagent Blank), press and hold **ON** button until spectrophotometer turns on.
11. Scroll to and select `PROGRAMMED TESTS`.
12. Scroll to and select `ALL TESTS` (or another sequence containing `8 Boron`) from `TESTING MENU`.
13. Scroll to and select `8 Boron` from menu.
14. At the end of the Reagent Blank 30 minute waiting period, remove Reagent Blank tube from meter chamber. Invert several times to mix.
15. Insert the tube into meter chamber, close lid and select `SCAN BLANK`.
16. Remove the tube from spectrophotometer.
17. At the end of the Sample Water 30 minute waiting period, remove Sample Water tube from Dark Storage Chamber. Invert several times to mix.
18. Insert tube into meter chamber, close lid and select `SCAN SAMPLE`. Record result in ppm boron.
19. Press **OFF** button to turn the spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

FREE CHLORINE–UDV

DPD METHOD–UNIT DOSE VIALS • CODE 4311-H

QUANTITY	CONTENTS	CODE
1	*Free Chlorine Unit Dose Vials, 10 pouches	4311-H

Equipment needed but not supplied:

STANDARD ACCESSORY PACKAGE • CODE 1961

1	Package of 3 Vials (empty)	0156
1	Syringe, 3 mL, plastic	1184
1	Foil Storage Bag	9467

Or:

ADVANCED ACCESSORY PACKAGE • CODE 1962

1	Pipettor	30528
1	Pipet Tips (0-5 mL)	30695
1	Cuvette Rack	31695
1	Package of 3 Vials (empty)	0156
1	Foil Storage Bag	9467

*WARNING: Reagents marked with an * are considered hazardous substances. To view or print a Material Safety Data Sheet (MSDS) for these reagents see MSDS CD or our web site. To obtain a printed copy, contact us by e-mail, phone or fax.

All water for cities and communities must be sanitized; even waters that come from clean sources, protected watersheds, reservoirs, and deep wells, are commonly sanitized to assure safety. Chlorine is the most commonly used sanitizer for several reasons: it is effective against a wide range of microorganisms, the cost is low, and the methods of applying it have been well developed. If an adequate concentration of chlorine is present in the water for a few minutes, disease producing bacteria will be destroyed. A number of conditions affect the sanitizing action of chlorine. In municipal systems these can be controlled so that if chlorine is detectable, it can be assumed that bacteria have been killed. The factors that influence the rate of kill are temperature, pH, presence of other materials that react with chlorine, time, and the concentrations of the various chlorine combinations that are formed in the water with ammonia and other substances that react with chlorine.

The fact that chlorine can be easily detected and measured makes chlorine a favorite water sanitizer of those concerned with the public safety of water supplies. Chlorine concentrations in the range of 0.1 to 0.4 parts per million are usually maintained in municipal supplies.

Chlorine can be added in the form of chlorine gas, liquid sodium hypochlorite (bleach), granular calcium hypochlorite or as organic chlorine compounds. Chlorine is not present in natural water supplies; if it is present it is the result of chlorination of a water supply or of chlorinated compounds being discharged as waste from industrial operations. The presence of chlorine in concentrations above 0.5 parts per million should be considered evidence of pollution from chlorine treated effluents or from a process in which high concentrations of chlorine are used.

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

RANGE: 0.00–10.00 ppm

METHOD: In the absence of iodide, free available chlorine reacts instantly with DPD to produce a red color. Subsequent addition of potassium iodide evokes a rapid color response from the combined forms of chlorine (chloramines).

SAMPLE HANDLING & PRESERVATION: Chlorine in aqueous solutions is not stable, and the chlorine content of samples or solutions, particularly weak solutions, will rapidly decrease. Exposure to sunlight or agitation will accelerate the reduction of chlorine present in such solutions. For best results, start analysis immediately after sampling. Samples to be analyzed for chlorine cannot be preserved or stored.

INTERFERENCES: The only interfering substance likely to be encountered in water is oxidized manganese. The extent of this interference can be determined by treating a sample with sodium arsenite to destroy the chlorine present so that the degree of interference can be measured.

Iodine and bromine can give a positive interference, but these are not normally present unless they have been added as sanitizers.

PROCEDURE

Use 10 mm square cell adapter

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select PROGRAMMED TESTS.
3. Scroll to and select ALL TESTS (or another sequence containing 16 Cl Free-UDV) from TESTING MENU.
4. Scroll to and select 16 Cl Free-UDV from menu.
5. Rinse a clean vial (0156) with sample water.
6. Use the syringe (1184) to add 3mL of sample to the vial.
7. Insert the vial into chamber, close the lid and select SCAN BLANK.
8. Remove the vial from the Spectro.
9. Use the syringe (1184) to add 3mL of sample to a *Free Chlorine UDV (4311).
10. Shake vigorously until powder dissolves completely.

    ☑NOTE: If powder residue remains in the bottom of the vial after inverting or air bubbles form, invert once more and tap bottom of vial sharply once or twice to dislodge powder and bubbles. Mix.
11. Immediately insert tube into chamber, close lid and select SCAN SAMPLE. Record result in ppm free chlorine.
12. Press **OFF** button to turn the spectrophotometer 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.

UDVs from opened pouches should be used promptly. Store unused vials from opened pouches in the Foil Storage Bag (9467) to extend the shelf life of the reagent. Generally, UDVs stored in the bag should be used within 10 days if the humidity is less than 50% and within 5 days if humidity is greater than 50%. The Foil Storage Bag contains a desiccant pack with indicator. When the indicator in the window turns from blue to pink, the bag should be replaced.

CADMIUM

PAN METHOD • CODE 4017

QUANTITY	CONTENTS	CODE
60 mL	Buffered Ammonia Reagent	4020-H
15 mL	Sodium Citrate, 10%	6253-E
30 mL	PAN Indicator	4021-G
30 mL	Stabilizing Reagent	4022-G
1	Pipet, 1.0 mL, plastic	0354
2	Pipet, 0.5 mL, plastic	0353

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Cadmium is used in batteries, paint pigments, electroplating processes, and with other metals in the preparation of alloys. The solubility of cadmium in natural water is proportional to the hardness or alkalinity of the water. Cadmium is not an essential nutrient for plants and animals. It is extremely toxic and can accumulate in the kidneys and liver.

APPLICATION: Drinking and surface waters; domestic and industrial wastewater.

RANGE: 0.00–1.00 Cadmium

METHOD: PAN (1-(2-Pyridylazo)-2-Naphthol) forms a red complex with Cadmium (Cd^{+2}) at a pH of 10.

SAMPLE HANDLING & PRESERVATION: Analyze sample as soon as possible. If sample must be stored, acidify with nitric acid to a pH below 2.

INTERFERENCES: Ag^{+2}, Co^{+2}, Cu^{+2}, Mn^{+2}, Ni^{+2}, Zn^{+2}, Y^{+3}, In^{+3}

PROCEDURE

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select `PROGRAMMED TESTS`.
3. Scroll to and select `ALL TESTS` (or another sequence containing `12 Cadmium`) from `TESTING MENU`.
4. Scroll to and select `12 Cadmium` from menu.
5. Rinse a tube (0290) with sample water. Fill to the 10 mL line with sample.
6. Insert the tube into chamber, close lid and select `SCAN BLANK`.
7. Remove tube from Spectro. Use the 1.0 mL pipet (0354) to add 1.0 mL of *Buffered Ammonia Reagent (4020). Swirl to mix.
8. Add two drops of Sodium Citrate, 10% (6253). Swirl to mix.
9. Use a 0.5 mL pipet (0353) to add 0.5 mL of PAN Indicator (4021). Swirl to mix.
10. Use a 0.5 mL pipet (0353) to add 0.5 mL Stabilizing Reagent (4022). Cap and mix.
11. Immediately insert tube into chamber, close lid and select `SCAN SAMPLE`. Record result.
12. Press **OFF** button to turn the spectrophotometer 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.

CALCIUM & MAGNESIUM (TOTAL) HARDNESS–UDV

UNIT DOSE VIALS • CODE 4309-H

QUANTITY	CONTENTS	CODE
1	Calcium Hardness Unit Dose Vials, 10 pouches	4309-H

Equipment needed but not supplied:

STANDARD ACCESSORY PACKAGE • CODE 1961

1	Package of 3 Vials (empty)	0156
1	Syringe, 3 mL, plastic	1184
1	Foil Storage Bag	9467

Or:

ADVANCED ACCESSORY PACKAGE • CODE 1962

1	Pipettor	30528
1	Pipet Tips (0-5 mL)	30695
1	Cuvette Rack	31695
1	Package of 3 Vials (empty)	0156
1	Foil Storage Bag	9467

*WARNING: Reagents marked with an * are considered hazardous substances. To view or print a Material Safety Data Sheet (MSDS) for these reagents see MSDS CD or our web site. To obtain a printed copy, contact us by e-mail, phone or fax.

APPLICATION: Drinking and surface waters; swimming pool water.

RANGE: 10–500 as $CaCO_3$ Total Hardness

METHOD: Calcium and magnesium react in a strongly buffered medium with an indicator to develop a pale purple color in proportion to the concentration.

SAMPLE HANDLING & PRESERVATION: Samples should be analyzed as soon as possible after collection. If storage is necessary, add 0.5 mL of 20 % hydrochloric acid per 100 mL of sample. However, the added acid will have to be neutralized with NaOH before testing.

INTERFERENCES: Heavy metals will interfere.

PROCEDURE

Use 10 mm square cell adapter

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select PROGRAMMED TESTS.
3. Scroll to and select ALL TESTS (or another sequence containing 13 Ca&Mg Hard-UDV) from TESTING MENU.
4. Scroll to and select 13 Ca&Mg Hard-UDV from menu.
5. Rinse a clean vial (0156) with sample water.
6. Use the syringe (1184) to add 3mL of sample to the vial.
7. Insert the vial into chamber, close lid and select SCAN BLANK.
8. Remove vial from Spectro.
9. Use the syringe (1184) to add 3mL of sample to a Calcium Hardness UDV vial (4309).
10. Shake vigorously for 10 seconds.

    ☑NOTE: If powder residue remains in the bottom of the vial after shaking, or if air bubbles form, invert vial once more and tap bottom of vial sharply once or twice to dislodge powder or bubbles. Mix.
11. Insert tube into chamber, close lid and select SCAN SAMPLE. Record result.
12. Press **OFF** button to turn the spectrophotometer 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.

UDVs from opened pouches should be used promptly. Store unused vials from opened pouches in the Foil Storage Bag (9467) to extend the shelf life of the reagent. Generally, UDVs stored in the bag should be used within 10 days if the humidity is less than 50% and within 5 days if humidity is greater than 50%. The Foil Storage Bag contains a desiccant pack with indicator. When the indicator in the window turns from blue to pink, the bag should be replaced.

CHLORIDE

ARGENTOMETRIC METHOD • CODE 3693-SC

QUANTITY	CONTENTS	CODE
50	*Chloride Spectrophotometric Grade Tablets	3885-H
1	Tablet Crusher	0175

*WARNING: Reagents marked with an * are considered hazardous substances. To view or print a Material Safety Data Sheet (MSDS) for these reagents see MSDS CD or our web site. To obtain a printed copy, contact us by e-mail, phone or fax.

Chloride is one of the major anions found in water and sewage. The presence of chlorides in large amounts may be due to the natural process of water passing through salt formations in the earth, or it may be evidence of the intrusion of seawater or pollution from industrial processes or domestic wastes. The salt content of water affects the distribution of plant and animal life in an aquatic system, based on the amount of salt they can tolerate.

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

RANGE: 0.0–30.0 ppm Chloride

METHOD: Silver nitrate reacts with chloride to form turbid silver chloride in proportion to the amount of chloride in the sample.

SAMPLE HANDLING & PRESERVATION: Collect samples in clean, chemically-resistant glass or plastic containers. No preservative is needed if sample is to be stored.

INTERFERENCES: Substances in amounts normally found in drinking water will not interfere. Bromide, iodide, cyanide, sulfide, thiosulfate, sulfide and orthophosphate will interfere.

PROCEDURE

Use universal sample holder

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select `PROGRAMMED TESTS.`
3. Scroll to and select `ALL TESTS` (or another sequence containing `21 Chloride-TT`) from `TESTING MENU.`
4. Scroll to and select `21 Chloride-TT` from menu.
5. Rinse a tube (0290) with sample water. Fill to 10 mL with sample.
6. Insert the tube into chamber, close lid and select `SCAN BLANK.`
7. Remove the tube from Spectro.
8. Add one *Chloride Spectrophotometric Grade Tablet (3885).
9. Use Tablet Crusher (0175) to crush tablet.
10. Cap tube.
11. Invert 2 times.
12. Wait 3 minutes. Do NOT mix.
13. Insert tube into chamber, close lid and select `SCAN SAMPLE`. Record result in ppm chloride.
14. 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.

The reagent system is temperature sensitive. The calibration is for 25°C. If sample is at 30°C, multiply resulting ppm by 1.1. If the sample is at 20°C, multiply resulting ppm by 0.9.

CHLORINE

LIQUID DPD METHOD • CODE 4859

QUANTITY	CONTENTS	CODE
30 mL	DPD 1A Free Chlorine Reagent	P-6740-G
30 mL	*DPD 1B Free Chlorine Reagent	*P-6741-G
30 mL	*DPD 3 Total Chlorine Reagent	*P-6743-G

*WARNING: Reagents marked with an * are considered hazardous substances. To view or print a Material Safety Data Sheet (MSDS) for these reagents see MSDS CD or our web site. To obtain a printed copy, contact us by e-mail, phone or fax.

All water for cities and communities must be sanitized; even waters that come from clean sources, protected watersheds, reservoirs, and deep wells, are commonly sanitized to assure safety. Chlorine is the most commonly used sanitizer for several reasons: it is effective against a wide range of microorganisms, the cost is low, and the methods of applying it have been well developed. If an adequate concentration of chlorine is present in the water for a few minutes, disease producing bacteria will be destroyed. A number of conditions affect the sanitizing action of chlorine. In municipal systems these can be controlled so that if chlorine is detectable, it can be assumed that bacteria have been killed. The factors that influence the rate of kill are temperature, pH, presence of other materials that react with chlorine, time, and the concentrations of the various chlorine combinations that are formed in the water with ammonia and other substances that react with chlorine.

The fact that chlorine can be easily detected and measured makes chlorine a favorite water sanitizer of those concerned with the public safety of water supplies. Chlorine concentrations in the range of 0.1 to 0.4 parts per million are usually maintained in municipal supplies.

Chlorine can be added in the form of chlorine gas, liquid sodium hypochlorite (bleach), granular calcium hypochlorite or as organic chlorine compounds. Chlorine is not present in natural water supplies; if it is present it is the result of chlorination of a water supply or of chlorinated compounds being discharged as waste from industrial operations. The presence of chlorine in concentrations above 0.5 parts per million should be considered evidence of pollution from chlorine treated effluents or from a process in which high concentrations of chlorine are used.

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

RANGE: 0.00–4.00 ppm Chlorine

METHOD: In the absence of iodide, free available chlorine reacts instantly with DPD to produce a red color. Subsequent addition of potassium iodide evokes a rapid color response from the combined forms of chlorine (chloramines).

SAMPLE HANDLING & PRESERVATION: Chlorine in aqueous solutions is not stable, and the chlorine content of samples or solutions, particularly weak solutions, will rapidly decrease. Exposure to sunlight or agitation will accelerate the reduction of chlorine present in such solutions. For best results, start analysis immediately after sampling. Samples to be analyzed for chlorine cannot be preserved or stored.

INTERFERENCE: The only interfering substance likely to be encountered in water is oxidized manganese. The extent of this interference can be determined by treating a sample with sodium arsenite to destroy the chlorine present so that the degree of interference can be measured.

Iodine and bromine can give a positive interference, but these are not normally present unless they have been added as sanitizers.

PROCEDURE–FREE CHLORINE

Use universal sample holder

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select `PROGRAMMED TESTS`.
3. Scroll to and select `ALL TESTS` (or another sequence containing `17 Cl DPD-Liq`) from `TESTING MENU`.
4. Scroll to and select `17 Cl DPD-Liq` from menu.
5. Rinse a tube (0290) with sample water. Fill to the 10 mL line with sample.
6. Insert the tube into chamber, close lid and select `SCAN BLANK`.
7. Remove the tube from spectrophotometer.
8. Add 5 drops of DPD 1A Free Chlorine Reagent (P-6740).
9. Add 5 drops of *DPD 1B Free Chlorine Reagent (P-6741). Cap and mix.
10. Insert tube into chamber, close lid and select `SCAN SAMPLE`. Record result as ppm free chlorine.

PROCEDURE–TOTAL CHLORINE

11. Add 5 drops of *DPD 3 Total Chlorine Reagent (P-6741). Cap and mix.
    ☑NOTE: For wastewater samples, *Standard Methods for the Examination of Water and Wastewater* recommends waiting 2 minutes for full color development.
12. Insert tube into chamber, close lid and select `SCAN SAMPLE`. Record result as ppm total chlorine.
13. Subtract the Free Chlorine reading from the Total Chlorine reading to determine ppm combined chlorine.
14. Press **OFF** button to turn the spectrophotometer 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.

FREE CHLORINE–UDV

DPD METHOD–UNIT DOSE VIALS • CODE 4311-H

QUANTITY	CONTENTS	CODE
1	*Free Chlorine Unit Dose Vials, 10 pouches	4311-H

Equipment needed but not supplied:

STANDARD ACCESSORY PACKAGE • CODE 1961

1	Package of 3 Vials (empty)	0156
1	Syringe, 3 mL, plastic	1184
1	Foil Storage Bag	9467

Or:

ADVANCED ACCESSORY PACKAGE • CODE 1962

1	Pipettor	30528
1	Pipet Tips (0-5 mL)	30695
1	Cuvette Rack	31695
1	Package of 3 Vials (empty)	0156
1	Foil Storage Bag	9467

*WARNING: Reagents marked with an * are considered hazardous substances. To view or print a Material Safety Data Sheet (MSDS) for these reagents see MSDS CD or our web site. To obtain a printed copy, contact us by e-mail, phone or fax.

All water for cities and communities must be sanitized; even waters that come from clean sources, protected watersheds, reservoirs, and deep wells, are commonly sanitized to assure safety. Chlorine is the most commonly used sanitizer for several reasons: it is effective against a wide range of microorganisms, the cost is low, and the methods of applying it have been well developed. If an adequate concentration of chlorine is present in the water for a few minutes, disease producing bacteria will be destroyed. A number of conditions affect the sanitizing action of chlorine. In municipal systems these can be controlled so that if chlorine is detectable, it can be assumed that bacteria have been killed. The factors that influence the rate of kill are temperature, pH, presence of other materials that react with chlorine, time, and the concentrations of the various chlorine combinations that are formed in the water with ammonia and other substances that react with chlorine.

The fact that chlorine can be easily detected and measured makes chlorine a favorite water sanitizer of those concerned with the public safety of water supplies. Chlorine concentrations in the range of 0.1 to 0.4 parts per million are usually maintained in municipal supplies.

Chlorine can be added in the form of chlorine gas, liquid sodium hypochlorite (bleach), granular calcium hypochlorite or as organic chlorine compounds. Chlorine is not present in natural water supplies; if it is present it is the result of chlorination of a water supply or of chlorinated compounds being discharged as waste from industrial operations. The presence of chlorine in concentrations above 0.5 parts per million should be considered evidence of pollution from chlorine treated effluents or from a process in which high concentrations of chlorine are used.

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

RANGE: 0.00–10.00 ppm

METHOD: In the absence of iodide, free available chlorine reacts instantly with DPD to produce a red color. Subsequent addition of potassium iodide evokes a rapid color response from the combined forms of chlorine (chloramines).

SAMPLE HANDLING & PRESERVATION: Chlorine in aqueous solutions is not stable, and the chlorine content of samples or solutions, particularly weak solutions, will rapidly decrease. Exposure to sunlight or agitation will accelerate the reduction of chlorine present in such solutions. For best results, start analysis immediately after sampling. Samples to be analyzed for chlorine cannot be preserved or stored.

INTERFERENCES: The only interfering substance likely to be encountered in water is oxidized manganese. The extent of this interference can be determined by treating a sample with sodium arsenite to destroy the chlorine present so that the degree of interference can be measured.

Iodine and bromine can give a positive interference, but these are not normally present unless they have been added as sanitizers.

PROCEDURE

Use 10 mm square cell adapter

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select `PROGRAMMED TESTS`.
3. Scroll to and select `ALL TESTS` (or another sequence containing `16 Cl Free-UDV`) from `TESTING MENU`.
4. Scroll to and select `16 Cl Free-UDV` from menu.
5. Rinse a clean vial (0156) with sample water.
6. Use the syringe (1184) to add 3mL of sample to the vial.
7. Insert the vial into chamber, close the lid and select `SCAN BLANK`.
8. Remove the vial from the Spectro.
9. Use the syringe (1184) to add 3mL of sample to a *Free Chlorine UDV (4311).
10. Shake vigorously until powder dissolves completely.

    ☑NOTE: If powder residue remains in the bottom of the vial after inverting or air bubbles form, invert once more and tap bottom of vial sharply once or twice to dislodge powder and bubbles. Mix.
11. Immediately insert tube into chamber, close lid and select `SCAN SAMPLE`. Record result in ppm free chlorine.
12. Press **OFF** button to turn the spectrophotometer 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.

UDVs from opened pouches should be used promptly. Store unused vials from opened pouches in the Foil Storage Bag (9467) to extend the shelf life of the reagent. Generally, UDVs stored in the bag should be used within 10 days if the humidity is less than 50% and within 5 days if humidity is greater than 50%. The Foil Storage Bag contains a desiccant pack with indicator. When the indicator in the window turns from blue to pink, the bag should be replaced.

TOTAL CHLORINE–UDV

DPD METHOD–UNIT DOSE VIALS • CODE 4312-H

QUANTITY	CONTENTS	CODE
1	*Total Chlorine Unit Dose Vials, 10 pouches	4312-H

Equipment needed but not supplied:

STANDARD ACCESSORY PACKAGE • CODE 1961

1	Package of 3 Vials (empty)	0156
1	Syringe, 3 mL, plastic	1184
1	Foil Storage Bag	9467

Or:

ADVANCED ACCESSORY PACKAGE • CODE 1962

1	Pipettor	30528
1	Pipet Tips (0-5 mL)	30695
1	Cuvette Rack	31695
1	Package of 3 Vials (empty)	0156
1	Foil Storage Bag	9467

*WARNING: Reagents marked with an * are considered hazardous substances. To view or print a Material Safety Data Sheet (MSDS) for these reagents see MSDS CD or our web site. To obtain a printed copy, contact us by e-mail, phone or fax.

All water for cities and communities must be sanitized; even waters that come from clean sources, protected watersheds, reservoirs, and deep wells, are commonly sanitized to assure safety. Chlorine is the most commonly used sanitizer for several reasons: it is effective against a wide range of microorganisms, the cost is low, and the methods of applying it have been well developed. If an adequate concentration of chlorine is present in the water for a few minutes, disease producing bacteria will be destroyed. A number of conditions affect the sanitizing action of chlorine. In municipal systems these can be controlled so that if chlorine is detectable, it can be assumed that bacteria have been killed. The factors that influence the rate of kill are temperature, pH, presence of other materials that react with chlorine, time, and the concentrations of the various chlorine combinations that are formed in the water with ammonia and other substances that react with chlorine.

The fact that chlorine can be easily detected and measured makes chlorine a favorite water sanitizer of those concerned with the public safety of water supplies. Chlorine concentrations in the range of 0.1 to 0.4 parts per million are usually maintained in municipal supplies.

Chlorine can be added in the form of chlorine gas, liquid sodium hypochlorite (bleach), granular calcium hypochlorite or as organic chlorine compounds. Chlorine is not present in natural water supplies; if it is present it is the result of chlorination of a water supply or of chlorinated compounds being discharged as waste from industrial operations. The presence of chlorine in concentrations above 0.5 parts per million should be considered evidence of pollution from chlorine treated effluents or from a process in which high concentrations of chlorine are used.

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

RANGE: 0.00–10.00 ppm

METHOD: In the absence of iodide, free available chlorine reacts instantly with DPD to produce a red color. Subsequent addition of potassium iodide evokes a rapid color response from the combined forms of chlorine (chloramines).

SAMPLE HANDLING & PRESERVATION: Chlorine in aqueous solutions is not stable, and the chlorine content of samples or solutions, particularly weak solutions, will rapidly decrease. Exposure to sunlight or agitation will accelerate the reduction of chlorine present in such solutions. For best results, start analysis immediately after sampling. Samples to be analyzed for chlorine cannot be preserved or stored.

INTERFERENCES: The only interfering substance likely to be encountered in water is oxidized manganese. The extent of this interference can be determined by treating a sample with sodium arsenite to destroy the chlorine present so that the degree of interference can be measured.

Iodine and bromine can give a positive interference, but these are not normally present unless they have been added as sanitizers.

PROCEDURE

Use 10 mm square cell adapter

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select `PROGRAMMED TESTS.`
3. Scroll to and select `ALL TESTS` (or another sequence containing `18 Cl Total-UDV`) from `TESTING MENU`.
4. Scroll to and select `18 Cl Total-UDV` from menu.
5. Rinse a clean vial (0156) with sample water.
6. Use the syringe (1184) to add 3mL of sample to the vial.
7. Insert the vial into chamber, close the lid and select `SCAN BLANK`.
8. Remove the vial from the Spectro.
9. Use the syringe (1184) to add 3mL of sample to a *Total Chlorine UDV (4312).
10. Shake vigorously until powder dissolves completely.

    ☑NOTE: If powder residue remains in the bottom of the vial after inverting or air bubbles form, invert once more and tap bottom of vial sharply once or twice to dislodge powder and bubbles. Mix.
11. Wait 2 minutes.
12. Insert tube into chamber, close lid and select `SCAN SAMPLE`. Record result in ppm total chlorine.
13. Press **OFF** button to turn the spectrophotometer 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.

UDVs from opened pouches should be used promptly. Store unused vials from opened pouches in the Foil Storage Bag (9467) to extend the shelf life of the reagent. Generally, UDVs stored in the bag should be used within 10 days if the humidity is less than 50% and within 5 days if humidity is greater than 50%. The Foil Storage Bag contains a desiccant pack with indicator. When the indicator in the window turns from blue to pink, the bag should be replaced.

CHLORINE DIOXIDE

DPD METHOD • CODE 3644-SC

QUANTITY	CONTENTS	CODE
100	*Chlorine DPD #1 Instrument Grade Tablets	*6903-J
15 mL	Glycine Solution	6811-E
1	Tablet Crusher	0175

*WARNING: Reagents marked with an * are considered hazardous substances. To view or print a Material Safety Data Sheet (MSDS) for these reagents see MSDS CD or our web site. To obtain a printed copy, contact us by e-mail, phone or fax.

Chlorine dioxide is used as a substitute for and an adjunct to chlorine in water treatment. It is better than chlorine in eliminating taste and odor in certain cases. Chlorine dioxide, unlike chlorine, does not produce carcinogenic chlorinated organic compounds when reacted with organic materials. A disadvantage is the higher cost of producing chlorine dioxide compared to chlorine.

APPLICATION: Drinking water; swimming pool water; domestic and industrial wastewater; food sanitation.

RANGE: 0.00–7.00 ppm Chlorine Dioxide

METHOD: Chlorine dioxide reacts with DPD to form a red color in proportion to the concentration.

SAMPLE HANDLING & PRESERVATION: Test as soon as possible to avoid loss of chlorine dioxide.

INTERFERENCE: Chlorine interference can be removed with the use of glycine. Very high levels of chloramines may interfere if the test result is not read immediately. Oxidized manganses interferes but can be removed with arsenite. Bromine and iodine interfere. Chromate interference can be removed with a thioacetamide blank correction.

PROCEDURE

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select `PROGRAMMED TESTS` from menu.
3. Scroll to and select `ALL TESTS` (or another sequence containing `20 CHLOR DIOX`) from `TESTING MENU`.
4. Scroll to and select `20 CHLOR DIOX` from menu.
5. Rinse a clean tube (0290) with sample water. Fill to 10 mL line with sample.
6. Insert tube into chamber, close lid and select `SCAN BLANK`.
7. Remove tube from Spectro. Pour out all but a sufficient amount of sample water to cover tablet. Add 5 drops of Glycine Solution (6811).

8. Add one *Chlorine DPD #1 Instrument Grade Tablet (6903). Crush tablet with tablet crusher. Cap and shake until tablet dissolves. Fill to 10 mL line with sample water. Solution will turn pink if chlorine dioxide is present. Wait 15 seconds, but no longer than 30 seconds. Mix.
9. Insert tube into chamber, close lid and select SCAN SAMPLE.
10. Press **OFF** button to turn spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

CHROMIUM-HEXAVALENT

DIPHENYLCARBOHYDRAZIDE METHOD • CODE 3645-SC

QUANTITY	CONTENTS	CODE
10 g	*Chromium Reagent Powder	*V-6276-D
1	Spoon, 0.1 g, plastic	0699
50	Filter Paper	0465-H
1	Funnel, Plastic	0459

*WARNING: Reagents marked with an * are considered hazardous substances. To view or print a Material Safety Data Sheet (MSDS) for these reagents see MSDS CD or our web site. To obtain a printed copy, contact us by e-mail, phone or fax.

Chromium may be present in water containing waste from industries such as metal plating. It is considered to be a toxic chemical and, if present in an amount of over 0.5 ppm, is evidence of contamination from untreated or incompletely treated industrial waste.

Chromium is one of a class of heavy metals found in the bottom mud of polluted bodies of water. Certain shellfish are capable of concentrating this element, endangering the health of its ultimate consumer, human or animal.

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

RANGE: 0.00–1.00 ppm Chromium

METHOD: Hexavalent chromium reacts with 1,5 diphenylcarbohydrazide under acidic conditions to form a red-purple color in proportion to the amount of chromium present.

SAMPLE HANDLING & PRESERVATION: Analysis for chromium should be made as quickly as possible after sample collection since storage in glass or plastic containers may result in low chromate values.

INTERFERENCES: High concentrations of mercurous and mercuric ions may impart a blue color to the chromium determination. Iron and vanadium in concentrations above 1 mg/L may result in a yellow color. However, the vanadium color becomes negligible 10 minutes after the addition of diphenylcarbohydrazide.

PROCEDURE

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select `PROGRAMMED TESTS` from menu.
3. Scroll to and select `ALL TESTS` (or another sequence containing `22 Chromium`) from `TESTING MENU`.
4. Scroll to and select `22 Chromium` 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 Spectro. Use the 0.1g spoon (0699) to add one measure of *Chromium Reagent Powder (V-6276). Cap and shake until powder dissolves. Wait 3 minutes for full color development.
8. During waiting period, fold a piece of filter paper (0465) in half then half again to form a cone. Push corners together to open end, and insert into funnel (0459).
9. At the end of 3 minute waiting period, filter sample into a clean tube. Mix. Insert tube into chamber, close lid and select `SCAN SAMPLE`. Record result.
10. Press **OFF** button to turn spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

☑NOTES: To convert result to ppm chromate (CrO_4^{2-}) multiply by 2.23. To convert result to ppm sodium chromate (Na_2CrO_4) multiply by 3.12.

Highly buffered waters may give poor results and require a more careful pH adjustment. Before adding *Chromium Reagent Powder, adjust pH of sample to pH 3-4.

CHROMIUM-HEXAVALENT, TRIVALENT & TOTAL

DIPHENYLCARBOHYDRAZIDE METHOD • CODE 3698-SC

QUANTITY	CONTENTS	CODE
60 mL	*Sulfuric Acid, 5N	*7681-H
10 g	*Chromium Reagent Powder	*V-6276-D
15 mL	*Sodium Azide, 5%	*7683-E
30 mL	Potassium Permanganate, 0.5%	7682-G
60 mL	Deionized Water	5115PT-H
1	Pipet, plain, glass, w/cap	0341
1	Pipet, 1.0 mL, plastic	0354
1	Spoon, 0.1 g, plastic	0699
1	Graduated Cylinder, 50 mL, glass	0418
1	Erlenmeyer Flask, 125 mL, glass	0431
1	Test tube holder	1113
1	Filter Paper	0465
1	Funnel, Plastic	0459

*WARNING: Reagents marked with an * are considered hazardous substances. To view or print a Material Safety Data Sheet (MSDS) for these reagents see MSDS CD or our web site. To obtain a printed copy, contact us by e-mail, phone or fax.

A toxic chemical, chromium is found in two forms in the water; trivalent chromium (Cr^{3+}) and hexavalent chromium (Cr^{6+}). Chromium enters the water from industrial waste. Hexavalent chromium is more toxic than trivalent chromium. Levels greater than 0.5 ppm indicate improperly treated industrial waste. It is important to maintain chromium levels at or below 0.5 ppm, because clams and other shellfish will store chromium in their systems, accumulating levels which may be dangerous to the consumer, whether human or animal.

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

RANGE: 0.00–1.00 ppm Chromium

METHOD: The trivalent chromium is converted to hexavalent chromium by permanganate under acidic conditions. Hexavalent chromium reacts with 1,5 diphenyl-carbohydrazide under acidic conditions to form a red-purple color in proportion to the amount of chromium present.

SAMPLE HANDLING & PRESERVATION: Analysis for chromium should be made as quickly as possible after sample collection since storage in glass or plastic containers may result in low chromate values.

INTERFERENCES: High concentrations of mercurous and mercuric ions may interfere.

HEXAVALENT CHROMIUM PROCEDURE

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select `22 Chromium` from menu.
3. Scroll to and select `ALL TESTS` (or another sequence containing `22 Chromium`) from `TESTING MENU`.
4. Scroll to and select `22 Chromium` from menu.
5. Rinse a clean tube (0290) with sample water. Fill to 10 mL line with sample water.
6. Insert tube into chamber, close lid and select `SCAN BLANK`.
7. Remove tube from Spectro. Use 0.1 g spoon (0699) to add one level measure of *Chromium Reagent Powder (V-6276). Cap and shake for one minute. Wait 3 minutes.
8. During the waiting period, fold a piece of filter paper in half, then in half again to form a cone. Push corners together to open end, and insert into funnel (0459).
9. At the end of 3 minute waiting period, filter sample into a clean tube (0290). Cap and mix. Insert tube into chamber, close lid and select `SCAN SAMPLE`. Record result.
10. Press **OFF** button to turn spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

TOTAL CHROMIUM WITH ACID DIGESTION PROCEDURE

1. Fill graduated cylinder (0418) to 50 mL line with sample water. Transfer to Erlenmeyer flask (0431).
2. Use the 1 mL pipet (0354) to add 5 mL (five measures) of *Sulfuric Acid, 5N (7681). Swirl to mix.

   ☑NOTE: Highly buffered waters may require pH adjustment. Adjust the pH of highly buffered samples to 7.0 ±0.5. Continue procedure.
3. Place flask on burner or hot plate. Bring solution to a gentle boil.
4. Fill pipet (0341) with Potassium Permanganate, 0.5% (7682). While gently swirling flask, add Potassium Permanganate, 0.5% (7682), 2 drops at a time to boiling solution, until solution turns a dark pink color which persists for 10 minutes. Continue boiling.
5. Add one drop of *Sodium Azide, 5% (7683) to boiling solution. Boil for approximately 30 seconds. If pink color does not fade, add another drop of *Sodium Azide, 5%. Continue adding *Sodium Azide, 5% one drop at a time until pink color disappears.
6. Remove flask from heat. Cool sample under running water. This is the digested sample.
7. Pour digested sample into clean graduated cylinder (0418). Dilute to the 50 mL line with Deionized Water (5115).
8. Press and hold **ON** button until spectrophotometer turns on.
9. Scroll to and select `PROGRAMMED TESTS` from menu.
10. Scroll to and select `ALL TESTS` (or another sequence containing `22 Chromium`) from `TESTING MENU`.
11. Scroll to and select `22 Chromium` from menu.
12. Rinse a clean tube (0290) with sample water. Fill to 10 mL line with sample water.
13. Insert tube into chamber, close lid and select `SCAN BLANK`.
14. Remove tube from Spectro. Use 0.1 g spoon (0699) to add one level measure of *Chromium Reagent Powder (V-6276). Cap and shake for one minute. Wait 3 minutes.
15. During the waiting period, fold a piece of filter paper in half, then in half again to form a cone. Push corners together to open end, and insert into funnel (0459).
16. Filter sample into a clean tube (0290). Cap and mix. Insert tube of filtered sample into chamber, close lid and select `SCAN SAMPLE`. Record result.
17. Press **OFF** button to turn spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

TRIVALENT CHROMIUM PROCEDURE

Subtract hexavalent chromium from total chromium. Record as ppm trivalent chromium.

Trivalent Chromium = Total Chromium–Hexavalent Chromium

CHROMIUM

DIPHENYLCARBOHYDRAZIDE METHOD • CODE 3697-SC

QUANTITY	CONTENTS	CODE
50	*Chromium Spectrophotometric Grade Tablets	3889-H
1	Tablet Crusher	0175

*WARNING: Reagents marked with an * are considered hazardous substances. To view or print a Material Safety Data Sheet (MSDS) for these reagents see MSDS CD or our web site. To obtain a printed copy, contact us by e-mail, phone or fax.

Chromium is one of a class of heavy metals found in the bottom mud of polluted bodies of water. It is considered to be a toxic chemical. Chromium will become concentrated in some shellfish, endangering the health of the human or animal that consumes them. Chromium may be present in water containing waste from industries such as metal plating. If more than 0.5 ppm chromium is present, it is evidence of contamination from untreated or incompletely treated industrial waste.

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

RANGE: 0.00–1.00 ppm Chromium

METHOD: Hexavalent chromium reacts with 1,5 diphenylcarbohydrazide under acidic conditions to form a red-purple color in proportion to the amount of chromium present.

SAMPLE HANDLING & PRESERVATION: Analysis for chromium should be made as quickly as possible. Storage in plastic or glass containers may result in low results.

INTERFERENCES: High concentrations of mercurous and mercuric ions may impart a blue color to the chromium determination. Iron and vanadium in concentrations above 1 ppm may result in a yellow color.

PROCEDURE

Use universal sample holder

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select `PROGRAMMED TESTS.`
3. Scroll to and select `ALL TESTS` (or another sequence containing `23 Chromium-TT`) from `TESTING MENU`.
4. Scroll to and select `23 Chromium-TT` from menu.
5. Rinse a tube (0290) with sample water. Fill to 10 mL with sample.
6. Insert the tube into chamber, close lid and select `SCAN BLANK`.
7. Remove the tube from Spectro.
8. Add one *Chromium Spectrophotometric Grade Tablet (3889).
9. Use Tablet Crusher (0175) to crush tablet.
10. Cap tube.
11. Shake vigorously for 30 seconds.
12. Wait 3 minutes.
13. Insert tube into chamber, close lid and select `SCAN SAMPLE`. Record result in ppm chromium.
14. Press **OFF** button to turn the spectrophotometer 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.

To convert results to ppm chromate (CrO_4^{-2}), multiply by 2.23. To convert result to ppm sodium chromate (Na_2CrO_4) multiply by 3.12.

COBALT

PAN METHOD • CODE 4851

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

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

APPLICATION: Industrial wastewater.

RANGE: 0.00–2.00 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

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select `PROGRAMMED TESTS`.
3. Scroll to and select `ALL TESTS` (or another sequence containing `24 Cobalt`) from `TESTING MENU`.
4. Scroll to and select `24 Cobalt` from menu.
5. Rinse a tube (0290) with sample water. Fill to 10 mL with sample.
6. Insert the tube into chamber, close lid and select `SCAN BLANK`.
7. Remove the tube from Spectro.
8. Use the 1.0 mL pipet (0354) to add 1 mL of *Cobalt Buffer (4852). Cap and mix.
9. Use the other 1.0 mL pipet (0354) to add 1 mL of *Cobalt Indicator Reagent (4853). Cap and mix.
10. Wait 3 minutes.
11. Use the 0.5 mL pipet (0353) to add 0.5 mL *Stabilizer Solution (4854). Cap and invert 15 times to thoroughly mix.
12. Wait 5 minutes. DO NOT MIX.
13. Insert tube into chamber, close lid and select `SCAN SAMPLE`. Record result in ppm cobalt.
14. Press **OFF** button to turn the spectrophotometer 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.

COD–LOW RANGE

MERCURY FREE DIGESTION • Code 0072-SC
MERCURY DIGESTION • Code 0075-SC

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

*WARNING: Reagents marked with an * are considered hazardous substances. To view or print a Material Safety Data Sheet (MSDS) for these reagents see MSDS CD or our web site. To obtain a printed copy, contact us by e-mail, phone or fax.

COD Low Level Mercury Free Tubes are not USEPA approved.

COD Low Level Mercury Tubes are USEPA approved.

☑NOTE: These reagents are for use with the SMART Spectro version 1.5 or higher.

Equipment needed but not supplied:

QUANTITY	CONTENTS	CODE
1	COD Adapter	5-0087
1	COD Reactor, 12 vial, 110V	5-0102
or 1	COD Reactor, 12 vial, 230V	5-0102-EX2
1	Volumetric Pipet, 1.0 mL	2-2110
1	Pipet Bulb	2-2164

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

APPLICATION: Domestic and industrial wastes.

RANGE: 0–150 mg/L COD

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 O_2 per ppm NO_2–N which is insignificant unless nitrite concentrations are very high. Other reduced inorganic compounds are stoichiometrically oxidized, causing a positive interference. Corrections can be made for these compounds based upon their stoichiometry and concentrations.

PROCEDURE

Use universal sample holder

1. Homogenize sample if necessary.
2. Preheat COD heater block to 150±2°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±2°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 **ON** button until spectrophotometer turns on.
12. Scroll to and select `PROGRAMMED TESTS` from menu.
13. Scroll to and select `ALL TESTS` (or another sequence containing `25 COD LR 0-150`) from `PROGRAMMED TESTS` menu.
14. Scroll to and select `25 COD LR 0-150` from menu.
15. Wipe the blank vial with a damp towel to remove fingerprints and smudges. Wipe with a dry towel.
16. 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`.
17. Remove tube from Spectro.
18. Insert digested water sample tube into chamber. Position tube as instructed above. Select `SCAN SAMPLE`. Record result. For the most accurate results, take three readings on each sample and average the results.
19. Press **OFF** button to turn spectrophotometer 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 0073-SC
MERCURY DIGESTION • CODE 0076-SC

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

*WARNING: Reagents marked with an * are considered hazardous substances. To view or print a Material Safety Data Sheet (MSDS) for these reagents see MSDS CD or our web site. To obtain a printed copy, contact us by e-mail, phone or fax.

COD Standard Level Mercury Free Tubes are not USEPA approved.

COD Standard Level Mercury Tubes are USEPA approved.

☑NOTE: These reagents are for use with the SMART Spectro version 1.5 or higher.

Equipment needed but not supplied:

QUANTITY	CONTENTS	CODE
1	COD Adapter	5-0087
1	COD Reactor, 12 vial, 110V	5-0102
or 1	COD Reactor, 12 vial, 230V	5-0102-EX2
1	Volumetric Pipet, 1.0 mL	2-2110
1	Pipet Bulb	2-2164

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

APPLICATION: Domestic and industrial wastes.

RANGE: 0–1500 mg/L COD

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 620 nm and is directly proportional to the COD of the sample.

SAMPLE HANDLING & PRESERVATION: Collect samples in glass and test as soon as possible. If samples must be stored, preservation is accomplished by the addition of concentrated H_2SO_4 to adjust the pH below 2. Samples with suspended solids should be homogenized in a blender (100 mL for 30 seconds) and then stirred gently with a magnetic stirrer.

INTERFERENCES: Volatile organic compounds are not oxidized to the extent that they are in the vapor above the digestion solution. Therefore, they do not contribute to the COD reading. Chloride concentrations above 10% of COD interfere with the mercury free tubes. Chloride above 2000 ppm will interfere with the mercury tubes. Nitrite gives a positive interference of 1.1 ppm O_2 per ppm NO_2–N which is insignificant unless nitrite concentrations are very high. Other reduced inorganic compounds are stoichiometrically oxidized, causing a positive interference. Corrections can be made for these compounds based upon their stoichiometry and concentrations.

PROCEDURE

Use universal sample holder

1. Homogenize sample if necessary.
2. Preheat COD heater block to 150±2°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±2°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 **ON** button until spectrophotometer turns on.
12. Scroll to and select `PROGRAMMED TESTS` from menu.
13. Scroll to and select `ALL TESTS` (or another sequence containing `26 COD SR 0-1500`) from `PROGRAMMED TESTS` menu.
14. Wipe the blank vial with a damp towel to remove fingerprints and smudges. Wipe with a dry towel.
15. Scroll to and select `26 COD SR 0-1500` from menu.
16. 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`.
17. Remove tube from Spectro.
18. Insert digested water sample tube into chamber. Position tube as instructed above. Select `SCAN SAMPLE`. Record result. For the most accurate results, take three readings on each sample and average the results.
19. Press **OFF** button to turn spectrophotometer 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 0074-SC
MERCURY DIGESTION • Code 0077-SC

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

*WARNING: Reagents marked with an * are considered hazardous substances. To view or print a Material Safety Data Sheet (MSDS) for these reagents see MSDS CD or our web site. To obtain a printed copy, contact us by e-mail, phone or fax.

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

☑NOTE: These reagents are for use with the SMART Spectro version 1.5 or higher.

Equipment needed but not supplied:

QUANTITY	CONTENTS	CODE
1	COD Adapter	5-0087
1	COD Reactor, 12 vial, 110V	5-0102
or 1	COD Reactor, 12 vial, 230V	5-0102-EX2
1	Volumetric Pipet, 1.0 mL	2-2110
1	Pipet Bulb	2-2164

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

APPLICATION: Domestic and industrial wastes.

RANGE: 0–15,000 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. Contains mercury sulfate to prevent interference from chloride. Nitrite gives a positive interference of 1.1 ppm O_2 per ppm NO_2–N, which is insignificant unless nitrite concentrations are very high. Other reduced inorganic compounds are stoichiometrically oxidized, causing a positive interference. Corrections can be made for these compounds based upon their stoichiometry and concentrations.

PROCEDURE

Use universal sample holder

1. Homogenize sample if necessary.
2. Preheat COD heater block to 150±2°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±2°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 **ON** button until spectrophotometer turns on.
12. Scroll to and select `PROGRAMMED TESTS` from menu.
13. Scroll to and select `ALL TESTS` (or another sequence containing `27 COD HR 0-15000`) from `PROGRAMMED TESTS` menu.
14. Wipe the blank vial with a damp towel to remove fingerprints and smudges. Wipe with a dry towel.
15. Scroll to and select `27 COD HR 0-15000` from menu.
16. 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`.
17. Remove tube from Spectro.
18. Insert digested water sample tube into chamber. Position tube as instructed above. Select `SCAN SAMPLE`. Record result. For the most accurate results, take three readings on each sample and average the results.
19. Press **OFF** button to turn spectrophotometer 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.

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

Use universal sample holder.

1. Press and hold **ON** burton until spectrophotometer turns on.
2. Scroll to and select `PROGRAMMED TESTS`.
3. Scroll to and select `ALL TESTS` (or another sequence containing `28 Color`) from `TESTING MENU`.
4. Scroll to and select `28 Color` from menu.
5. Rinse a tube (0290) with color-free water (distilled or deionized water). Fill to 10 mL line with color-free water.
6. Insert the tube into chamber, close lid and select `SCAN BLANK`.
7. Remove tube from spectrophotometer. Empty tube.
8. Rinse tube with sample water. Fill to 10 mL line with water sample.
9. Insert tube with sample water, close lid and select `SCAN SAMPLE`. Record result in color units.
10. Press **OFF** button to turn the spectrophotometer 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 an * are considered hazardous substances. To view or print a Material Safety Data Sheet (MSDS) for these reagents see MSDS CD or our web site. To obtain a printed copy, contact us by e-mail, phone or fax.

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; swimming pool water.

RANGE: 0.00–2.00 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

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select `PROGRAMMED TESTS`.
3. Scroll to and select `ALL TESTS` (or another sequence containing 31 `Cu-Cuprizone`) from `TESTING MENU`.
4. Scroll to and select `31 Cu-Cuprizone` from menu.
5. Rinse a tube (0290) with sample water. Fill to the 10 mL line with sample.
6. Insert the tube into chamber, close lid and select `SCAN BLANK`.
7. Remove tube from Spectro and add 5 drops of Copper A (P-6367). Cap and mix.
8. Add 5 drops of *Copper B (P-6368). Cap and mix.
9. Wait 5 minutes. Mix.
10. Insert tube into chamber, close lid and select `SCAN SAMPLE`. Record result.
11. Press **OFF** button to turn the spectrophotometer 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–LOW RANGE

BICINCHONINIC ACID METHOD • CODE 3640-SC

QUANTITY	CONTENTS	CODE
50	*Copper Tablets	T-3808-H

*WARNING: Reagents marked with an * are considered hazardous substances. To view or print a Material Safety Data Sheet (MSDS) for these reagents see MSDS CD or our web site. To obtain a printed copy, contact us by e-mail, phone or fax.

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: 0.00–3.50 ppm Copper

METHOD: Copper ions form a purple complex with bicinchoninic acid around pH 6-7, 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% HCl 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: High concentrations of oxidizing agents, calcium, and magnesium interfere. Silver can also interfere.

PROCEDURE

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select `PROGRAMMED TEST` from menu.
3. Scroll to and select `ALL TESTS` (or another sequence containing `29 Copper BCA-LR`) from `TESTING MENU`.
4. Scroll to and select `29 Copper BCA-LR` from menu.
5. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
6. Insert tube into chamber, close lid and select `SCAN BLANK`.
7. Remove tube from Spectro and add one *Copper Tablet (T-3808). Cap and shake vigorously until tablet dissolves. Solution will turn purple if copper is present. Wait 2 minutes.
8. At end of 2 minute waiting period, mix, insert tube into chamber, close lid and select `SCAN SAMPLE`. Record result.
9. Press **OFF** button to turn spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

COPPER–HIGH RANGE

DIETHYLDITHIOCARBAMATE METHOD • CODE 3646-SC

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

*WARNING: Reagents marked with an * are considered hazardous substances. To view or print a Material Safety Data Sheet (MSDS) for these reagents see MSDS CD or our web site. To obtain a printed copy, contact us by e-mail, phone or fax.

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

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select `PROGRAMMED TESTS` from menu.
3. Scroll to and select `ALL TESTS` (or another sequence containing `32 Copper DDC`) from `TESTING MENU`.
4. Scroll to and select `32 Copper DDC` 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 Spectro and add 5 drops of *Copper 1 (6446). Cap and mix. Solution will turn yellow if copper is present.
8. Insert tube into chamber, close lid and select `SCAN SAMPLE`. Record result.
9. Press **OFF** button to turn spectrophotometer 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.

COPPER–UDV

BICINCHONINIC ACID METHOD–UNIT DOSE VIALS
CODE 4314-H

QUANTITY	CONTENTS	CODE
1	Copper Unit Dose Vials, 10 pouches	4314-H

Equipment needed but not suppled:

STANDARD ACCESSORY PACKAGE • CODE 1961

1	Package of 3 Vials (empty)	0156
1	Syringe, 3 mL, plastic	1184
1	Foil Storage Bag	9467

Or:

ADVANCED ACCESSORY PACKAGE • CODE 1962

1	Pipettor	30528
1	Pipet Tip (0-5 mL)	30695
1	Cuvette Rack	31695
1	Package of 3 Vials (empty)	0156
1	Foil Storage Bag	9467

*WARNING: Reagents marked with an * are considered hazardous substances. To view or print a Material Safety Data Sheet (MSDS) for these reagents see MSDS CD or our web site. To obtain a printed copy, contact us by e-mail, phone or fax.

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 saline waters; domestic and industrial wastes.

RANGE: 0.00–4.00 Copper

METHOD: Cupric ions form a purple complex with bicinchoninic acid around pH 6–7, 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: High concentrations of oxidizing agents, calcium, and magnesium interfere. Silver can also interfere.

PROCEDURE

Use 10 mm square cell adapter.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select `PROGRAMMED TESTS`.
3. Scroll to and select `ALL TESTS` (or another sequence containing `33 Copper-UDV`) from `TESTING MENU`.
4. Scroll to and select `33 Copper-UDV` from menu.
5. Rinse a clean vial (0156) with sample water.
6. Use the syringe (1184) to add 3 mL of sample to the vial.
7. Insert the vial into chamber, close lid and select `SCAN BLANK`.
8. Remove vial from Spectro.
9. Use the syringe (1184) to add 3 mL of sample to a Copper UDV vial (4314).
10. Wait 2 minutes.
11. Invert vial 3 times to mix.

    ☑NOTE: If powder residue remains in the bottom of the vial after inverting, or air bubbles form, invert once more and tap bottom of vial sharply once or twice to dislodge powder or bubbles. Mix.
12. Insert tube into chamber, close lid and select `SCAN SAMPLE`. Record result.
13. Press **OFF** button to turn the spectrophotometer 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.

CYANIDE

PYRIDINE-BARBITURIC ACID METHOD • CODE 3660-SC

QUANTITY	CONTENTS	CODE
60 mL	Cyanide Buffer	2850PS-H
5 g	*Cyanide Cl Reagent	*2794DS-C
5 g	*Cyanide Indicator Reagent	*2793DS-C
15 mL	*Hydrochloric Acid 1N	*6130-E
15 mL	*Sodium Hydroxide 1N	*4004-E
2	Spoons, 0.1 g, plastic	0699
1	Pipet, plastic, 1.0 mL	0354
1	pH Short Range Test Paper, pH 9–14	2955
1	Stirring Rod, Plastic	0519

*WARNING: Reagents marked with an * are considered hazardous substances. To view or print a Material Safety Data Sheet (MSDS) for these reagents see MSDS CD or our web site. To obtain a printed copy, contact us by e-mail, phone or fax.

The presence of cyanide in water has a significant effect on the biological activity of the system. Cyanides may exist in water in a variety of forms which vary in toxicity. Cyanide is a by-product of industrial waste from petroleum refining and plating.

APPLICATION: Low level concentrations in drinking and surface waters; domestic and industrial waters. This method determines only those cyanides amenable to chlorination.

RANGE: 0.00–0.500 ppm Cyanide

METHOD: Cyanides react with a chlorine donor to form cyanogen chloride, which subsequently reacts with Pyridine and Barbituric Acid to form a red-blue compound in proportion to the amount of cyanide originally present. The concentration of the red-blue compound is determined spectrophotometrically.

SAMPLE HANDLING & PRESERVATION: Cyanide solutions tend to be unstable and should be analyzed as soon as possible. Samples can be stabilized by adjusting the pH to greater than 12 with NaOH. However, the pH will have to be readjusted to pH 10.5 before performing the test.

INTERFERENCES: Oxidizing agents and aldehydes can react with cyanide, while reducing agents, such as sulfite, react with the chlorine donor; both can cause negative interferences. Thiocyanate and cyanogen chloride both react as cyanide in this test and will give a positive interference. Color and turbidity can also interfere.

PROCEDURE

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select `PROGRAMMED TESTS` from menu.
3. Scroll to and select `ALL TESTS` (or another sequence containing `35 Cyanide`) from `TESTING MENU`.
4. Scroll to and select `35 Cyanide` from menu.
5. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
6. Dip the end of plastic rod (0519) into water sample and touch it to a small piece (1/4 inch) of pH test paper (2955) to wet paper. Read pH immediately from color chart.

   a) If pH is below 10, raise the pH by adding *Sodium Hydroxide, 1N (4004) one drop at a time with stirring. Check pH after each drop with a new piece of pH test paper. Continue adjustment until pH is between 10.5 and 11.0.

   b) If pH is above 11.5, lower pH by adding *Hydrochloric Acid (6130) one drop at a time with stirring. Check pH after each drop with a new piece of pH test paper. Continue adjustment until pH is between 10.5 and 11.0.
7. Insert tube into chamber, close lid and select `SCAN BLANK`.
8. Remove tube from Spectro. Use the 1.0 mL pipet (0354) to add 1.0 mL of Cyanide Buffer (2850PS) to tube. Cap and mix.
9. Use one 0.1 g spoon (0699) to add one level measure of *Cyanide Cl Reagent (2794DS). Cap and invert 10 times to mix. Wait 30 seconds.
10. During the 30 second waiting period, carefully fill a second 0.1 g spoon (0699) with one level measure of *Cyanide Indicator Reagent (2793DS).
11. At the end of the 30 second waiting period, immediately add the level measure of *Cyanide Indicator Reagent (2793DS). Cap and shake vigorously for 20 seconds. Wait 20 minutes for maximum color development.
12. At the end of the twenty minute waiting period, mix, insert tube into chamber, close lid and select `SCAN SAMPLE`. Record result.
13. Press **OFF** button to turn spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

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 an * are considered hazardous substances. To view or print a Material Safety Data Sheet (MSDS) for these reagents see MSDS CD or our web site. To obtain a printed copy, contact us by e-mail, phone or fax.

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

APPLICATION: Swimming pool water.

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 15).

PROCEDURE

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select `PROGRAMMED TESTS`.
3. Scroll to and select `ALL TESTS` (or another sequence containing `36 Cyanuric`) from `TESTING MENU`.
4. Scroll to and select `36 Cyanuric` 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 Spectro and pour out water. Use a graduated cylinder or similar to measure 5 mL of sample water and pour into colorimeter tube.
8. Use the 5 mL syringe (0807) to add 5 mL of *Cyanuric Acid Test Solution (4856). Cap and mix thoroughly. A precipitate will form if cyanuric acid is present. Wait 1 minute.

   ☑NOTE: This reagent bottle has a special fitting which enables the syringe to be inserted into the top of the bottle. With syringe in place, invert bottle and withdraw syringe plunger until 5 mL of reagent is contained in the syringe barrel. Remove syringe from reagent bottle and depress plunger to dispense into the tube.
9. At end of 1 minute waiting period, mix thoroughly, insert tube into chamber, close lid and select `SCAN SAMPLE`. Record result.
10. Press **OFF** button to turn spectrophotometer 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 ±4°C.

CYANURIC ACID–UDV

MELAMINE METHOD–TURBIDITY–UNIT DOSE VIALS
CODE 4313-H

QUANTITY	CONTENTS	CODE
1	Cyanuric Acid Unit Dose Vials, 10 pouches	4313-H

Equipment but not suppled:

STANDARD ACCESSORY PACKAGE • CODE 1961

1	Package of 3 Vials (empty)	0156
1	Syringe, 3 mL, plastic	1184
1	Foil Storage Bag	9467

Or:

ADVANCED ACCESSORY PACKAGE • CODE 1962

1	Pipettor	30528
1	Pipet Tip (0-5 mL)	30695
1	Cuvette Rack	31695
1	Package of 3 Vials (empty)	0156
1	Foil Storage Bag	9467

*WARNING: Reagents marked with an * are considered hazardous substances. To view or print a Material Safety Data Sheet (MSDS) for these reagents see MSDS CD or our web site. To obtain a printed copy, contact us by e-mail, phone or fax.

Cyanuric acid is added to swimming pool water as a stabilizing agent for free chlorine residuals. It minimizes the loss of chlorine from the action of ultraviolet rays in sunlight. Cyanuric acid levels 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 water.

RANGE: 5–150 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 16).

PROCEDURE

Use 10 mm square cell adapter.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select PROGRAMMED TESTS.
3. Scroll to and select ALL TESTS (or another sequence containing 37 Cyanuric-UDV) from TESTING MENU.
4. Scroll to and select 37 Cyanuric-UDV from menu.
5. Rinse a clean vial (0156) with sample water.
6. Use the syringe (1184) to add 3 mL of sample to the vial.
7. Insert the vial into chamber, close lid and select SCAN BLANK.
8. Remove vial from Spectro.
9. Use the syringe (1184) to add 3 mL of sample to a Cyanuric Acid UDV vial (4313).
10. Invert vial 3 times to mix.
11. Wait 2 minutes.
12. Invert vial 3 times to mix.

    ☑NOTE: If powder residue remains in the bottom of the vial after inverting, or air bubbles forms, invert vial once more and tap bottom of vial sharply once or twice to dislodge powder or bubbles. Mix.
13. Insert tube into chamber, close lid and select SCAN SAMPLE. Record result.
14. Press **OFF** button to turn the spectrophotometer 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.

UDVs from opened pouches should be used promptly. Store unused vials from opened pouches in the Foil Storage Bag (9467) to extend the shelf life of the reagent. Generally, UDVs stored in the bag should be used within 10 days if the humidity is less than 50% and within 5 days if humidity is greater than 50%. The Foil Storage Bag contains a desiccant pack

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 an * are considered hazardous substances. To view or print a Material Safety Data Sheet (MSDS) for these reagents see MSDS CD or our web site. To obtain a printed copy, contact us by e-mail, phone or fax.

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: Drinking and surface waters; domestic and industrial wastewaters.

RANGE: 0.0–12.0 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

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select `PROGRAMMED TESTS`.
3. Scroll to and select `ALL TESTS` (or another sequence containing `39 OXYGEN`) from `TESTING MENU`.
4. Scroll to and select `39 OXYGEN` from menu.
5. Rinse a clean tube (0290) with untreated sample water. Fill to the 10 mL line with sample. This tube is the BLANK.
6. Insert tube into chamber, close lid and select `SCAN BLANK`.
7. Fill a second tube (0290) to the 10 line with the treated "Fixed" sample. This tube is the SAMPLE.
8. Remove BLANK from Spectro, insert SAMPLE tube into chamber, close lid and select `SCAN SAMPLE`. Record result.
9. Press **OFF** button to turn spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

FLUORIDE

SPADNS METHOD • CODE 3647-01-SC

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 an * are considered hazardous substances. To view or print a Material Safety Data Sheet (MSDS) for these reagents see MSDS CD or our web site. To obtain a printed copy, contact us by e-mail, phone or fax.

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

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select `PROGRAMMED TESTS`.
3. Scroll to and select `ALL TESTS` (or another sequence containing `41 Fluoride`) from `TESTING MENU`.
4. Scroll to and select `41 Fluoride` from menu.
5. This test requires a reagent blank. Rinse a clean tube (0290) with clear, colorless, fluoride free water. Fill to the 10 mL line with clear, colorless, fluoride free water.
6. Use the 0.5 mL pipet (0353) to add 0.5 mL of *Sodium Arsenite Solution (4128). Cap and mix.
7. Use the 1.0 mL pipet (0354) to add 2 measures of *Acid-Zirconyl SPADNS Reagent (3875). Cap and mix thoroughly. (This is the reagent blank.)
8. Insert tube into chamber, close lid and select `SCAN BLANK`.
9. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample water. Repeat steps 6 and 7.
10. Insert tube into chamber, close lid and select `SCAN SAMPLE`. Record result.
11. Press **OFF** button to turn spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

HARDNESS

PHTHALEN PURPLE METHOD • CODE 3691-SC

QUANTITY	CONTENTS	CODE
50	*Hardness Spectrophotometric Grade Tablets	3883-H
1	Tablet Crusher	0175

*WARNING: Reagents marked with an * are considered hazardous substances. To view or print a Material Safety Data Sheet (MSDS) for these reagents see MSDS CD or our web site. To obtain a printed copy, contact us by e-mail, phone or fax.

Hardness refers to the total amount of calcium and magnesium in the water. All water contains some natural hardness that will vary regionally and from source to source within a region. If there is too little hardness, the water is considered soft and tends to be corrosive. If the water hardness level is too high, the calcium and magnesium may come out of solution and form scale deposits. Hard water will also reduce the ability of soap to form lather. The control of hardness is an important step in many domestic and industrial water systems.

APPLICATION: Drinking and pool waters; domestic and industrial wastewaters.

RANGE: 0–350 ppm Harness as $CaCO_3$

METHOD: Calcium and magnesium ions react with Phthalein Purple at a pH of about 9 to form a purple color in proportion to the hardness concentration.

SAMPLE HANDLING & PRESERVATION: Sample should be analyzed as soon as possible after collection. Fill bottle completely and cap tightly.

INTERFERENCES: High concentrations of dissolved metals

PROCEDURE

Use universal sample holder

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select PROGRAMMED TESTS.
3. Scroll to and select ALL TESTS (or another sequence containing 44 Hard-TT) from TESTING MENU.
4. Scroll to and select 44 Hard-TT from menu.
5. Rinse a tube (0290) with sample water. Fill to 10 mL with sample.
6. Insert the tube into chamber, close lid and select SCAN BLANK.
7. Remove the tube from Spectro.
8. Add one *Hardness Spectrophotometric Grade Tablet (3883).
9. Use Tablet Crusher (0175) to crush tablet.
10. Cap tube.
11. Shake for 10 seconds.
12. Wait 1 minutes.
13. Insert tube into chamber, close lid and select SCAN SAMPLE. Record result in ppm hardness.
14. 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.

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 an * are considered hazardous substances. To view or print a Material Safety Data Sheet (MSDS) for these reagents see MSDS CD or our web site. To obtain a printed copy, contact us by e-mail, phone or fax.

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

APPLICATION: Boiler and cooling waters; industrial wastewaters.

RANGE: 0.00–1.00 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

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select `PROGRAMMED TESTS`.
3. Scroll to and select `ALL TESTS` (or another sequence containing `45 Hydrazine`) from `TESTING MENU`.
4. Scroll to and select `45 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 Spectro. 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 spectrophotometer 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.

HYDROGEN PEROXIDE–LOW RANGE

DPD METHOD • CODE 3662-SC

QUANTITY	CONTENTS	CODE
30 mL	*Hydrogen Peroxide Reagent #1	*6452-G
100	*Hydrogen Peroxide LR Tablets	*6454-J
1	Tablet Crusher	0175

*WARNING: Reagents marked with an * are considered hazardous substances. To view or print a Material Safety Data Sheet (MSDS) for these reagents see MSDS CD or our web site. To obtain a printed copy, contact us by e-mail, phone or fax.

Hydrogen peroxide, H_2O_2, is a colorless compound that is widely used as a bleaching or decolorizing agent in the manufacture of many commercial products. As an oxidizing compound it is also used in the treatment of sewage to reduce odors and corrosion due to hydrogen sulfide. It may also be used as a sanitizing agent for water treatment. Hydrogen peroxide is relatively unstable, and for this reason it dissipates quickly and leaves no residuals.

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

RANGE: 0.00–1.50 ppm Hydrogen Peroxide

METHOD: Hydrogen peroxide reacts with an excess of potassium iodide through the action of a catalyst and buffer to release an equivalent amount of iodine. The iodine in turn reacts with diethyl-p-phenylenediamine (DPD) to produce a pink-red color in proportion to the iodine released.

SAMPLE HANDLING & PRESERVATION: Hydrogen peroxide is not stable in aqueous solutions. Exposure to sunlight and agitation will accelerate the reduction of hydrogen peroxide in dilute solutions. For best results start analysis immediately after sampling.

INTERFERENCE: The likelihood of other oxidizing compounds interfering with this method is eliminated by the presence of hydrogen peroxide. Manganese may interfere and should be removed before analysis.

PROCEDURE

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select `PROGRAMMED TESTS`.
3. Scroll to and select `ALL TESTS` (or another sequence containing `46 H Peroxide-LR`) from `TESTING MENU`.
4. Scroll to and select `46 H Peroxide-LR` from menu.
5. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
6. Insert tube into chamber, close lid and select `SCAN BLANK`. (See Note)
7. Remove tube from Spectro and add 4 drops of *Hydrogen Peroxide Reagent #1 (6452). Cap and mix.
8. Add one *Hydrogen Peroxide LR Tablet (6454). Crush tablet with tablet crusher (0175). Cap and mix for 30 seconds. Solution will turn pink if hydrogen peroxide is present. Wait 5 minutes for full color development.
9. At end of 5 minute waiting period, mix, insert tube into chamber, close lid and select `SCAN SAMPLE`. Record result.
10. Press **OFF** button to turn spectrophotometer 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±4°C.

HYDROGEN PEROXIDE–HIGH RANGE

DPD Method • CODE 4045

QUANTITY	CONTENTS	CODE
30 mL	*Hydrogen Peroxide Reagent #1	*6452-G
100	*Hydrogen Peroxide LR Tablets	*6454-J
1	Tablet Crusher	0175
1	Pipet, glass	0342

*WARNING: Reagents marked with an * are considered hazardous substances. To view or print a Material Safety Data Sheet (MSDS) for these reagents see MSDS CD or our web site. To obtain a printed copy, contact us by e-mail, phone or fax.

Large quantities of hydrogen peroxide are added to a swimming pool to "shock" it. Shocking breaks down waste products and re-establishes a positive level of sanitizer. While many types of shock can be used with chlorine or bromine pools, only hydrogen peroxide can be used to shock biguanide pools.

Hydrogen peroxide, H_2O_2, is a colorless compound that is widely used as a bleaching or decolorizing agent in the manufacture of many commercial products. As an oxidizing compound it is also used in the treatment of sewage to reduce odors and corrosion due to hydrogen sulfide. It may also be used as a sanitizing agent for water treatment. Hydrogen peroxide is relatively unstable, and for this reason it dissipates quickly and leaves no residuals.

APPLICATION: Drinking, industrial, domestic and swimming pool waters

RANGE: 0–60 ppm Hydrogen Peroxide

METHOD: Hydrogen peroxide reacts with an excess of potassium iodide through the action of a catalyst and buffer to release an equivalent amount of iodine. The iodine in turn reacts with diethyl-p-phenylenediamine (DPD) to produce a pink-red color in proportion to the iodine released.

SAMPLE HANDLING & PRESERVATION: Hydrogen peroxide is not stable in aqueous solutions. Exposure to sunlight and agitation will accelerate the reduction of hydrogen peroxide in dilute solutions. For best results start analysis immediately after sampling.

INTERFERENCES: The likelihood of other oxidizing compounds interfering with this method is eliminated by the presence of hydrogen peroxide. Manganese may interfere and should be removed before analysis

PROCEDURE

Use universal sample holder

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select `PROGRAMMED TESTS`.
3. Select `ALL TESTS` (or another sequence containing `47 H Per-HR`) from `TESTING MENU`.
4. Scroll to and select `47 H Per-HR` from menu.
5. Use the pipet (0342) to add 5 drops of the sample water to a tube (0290).
6. Dilute to the 10 mL line with distilled or hydrogen peroxide-free water.
7. Insert the tube into chamber, close lid and select `SCAN BLANK`.
8. Remove the tube from spectrophotometer and add 4 drops of *Hydrogen Peroxide Reagent #1 (6452). Cap and mix.
9. Add one *Hydrogen Peroxide LR Tablet (6454). Crush tablet with Tablet Crusher (0175). Cap and mix for 30 seconds. Solution will turn pink if hydrogen peroxide is present. Wait 5 minutes for full color development.
10. At the 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 the spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

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

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

HYDROGEN PEROXIDE–SHOCK

DPD Method • CODE 4045

QUANTITY	CONTENTS	CODE
30 mL	*Hydrogen Peroxide Reagent #1	*6452-G
100	*Hydrogen Peroxide LR Tablets	*6454-J
1	Tablet Crusher	0175
1	Pipet, glass	0342

*WARNING: Reagents marked with an * are considered hazardous substances. To view or print a Material Safety Data Sheet (MSDS) for these reagents see MSDS CD or our web site. To obtain a printed copy, contact us by e-mail, phone or fax.

Large quantities of hydrogen peroxide shock are added to a swimming pool to "shock" it. Shocking breaks down waste products and re-establishes a positive level of sanitizer. While many types of shock can be used with chlorine or bromine pools, only hydrogen peroxide shock can be used to shock biguanide pools.

APPLICATION: Swimming pools

RANGE: 0–225 ppm Hydrogen Peroxide Shock

METHOD: Hydrogen peroxide shock reacts with an excess of potassium iodide through the action of a catalyst and buffer to release an equivalent amount of iodine. The iodine in turn reacts with diethyl-p-phenylenediamine (DPD) to produce a pink-red color in proportion to the iodine released.

SAMPLE HANDLING & PRESERVATION: Hydrogen peroxide shock is not stable in aqueous solutions. Exposure to sunlight and agitation will accelerate the reduction of hydrogen peroxide in dilute solutions. For best results start analysis immediately after sampling.

INTERFERENCES: The likelihood of other oxidizing compounds interfering with this method is eliminated by the presence of hydrogen peroxide. Manganese may interfere and should be removed before analysis.

PROCEDURE

Use universal sample holder

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select `PROGRAMMED TESTS`.
3. Select `ALL TESTS` (or another sequence containing `48 H Per Shock`) from `TESTING MENU`.
4. Scroll to and select `48 H Per Shock` from menu.
5. Use the pipet (0342) to add 5 drops of the sample water to a tube (0290).
6. Dilute to the 10 mL line with distilled or hydrogen peroxide-free water.
7. Insert the tube into chamber, close lid and select `SCAN BLANK`.
8. Remove the tube from spectrophotometer and add 4 drops of *Hydrogen Peroxide Reagent #1 (6452). Cap and mix.
9. Add one *Hydrogen Peroxide LR Tablet (6454). Crush tablet with Tablet Crusher (0175). Cap and mix for 30 seconds. Solution will turn pink if hydrogen peroxide is present. Wait 5 minutes for full color development.
10. At the 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 the spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

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

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

IRON

BIPYRIDYL METHOD • CODE 3648-SC

QUANTITY	CONTENTS	CODE
30 mL	*Iron Reagent #1	*4450-G
5 g	*Iron Reagent #2 Powder	*V-4451-C
1	Pipet, 0.5 mL, plastic	0353
1	Spoon, 0.1 g, plastic	0699

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Most natural waters contain some iron. Its presence may vary from small traces to very large amounts in water which is contaminated by acid mine wastes. For domestic use, the concentration should not exceed 0.2 ppm and for some industrial applications not even a trace of iron can be tolerated. There are many means available for removing or reducing the iron content. Water softening resins are effective for removing small amounts of iron and special ion exchange materials are selective for iron removal. High concentrations of iron can be removed by such chemical processes as oxidation and lime or lime-soda softening. Because of the many means of removing or reducing the amount of iron in water, the particular method employed will depend largely on the form of iron which is present and the end use of the treated water.

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

RANGE: 0.00–6.00 Iron

METHOD: Ferric iron is reduced to ferrous iron and subsequently forms a colored complex with bipyridyl for a quantitative measure of total iron.

SAMPLE HANDLING & PRESERVATION: The sample container should be cleaned with acid and rinsed with deionized water. Addition of acid to adjust the sample to pH 2–3 will prevent deposition of iron on the container walls. Samples should be analyzed as soon as possible.

INTERFERENCES: Strong oxidizing agents interfere, as well as copper and cobalt in excess of 5.0 mg/L.

PROCEDURE

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select PROGRAMMED TESTS.
3. Scroll to and select ALL TESTS (or another sequence containing 51 Iron Bipyr) from TESTING MENU.
4. Scroll to and select 51 Iron Bipyr 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 Spectro. Use the 0.5 mL pipet (0353) to add one measure of *Iron Reagent #1 (V-4450). Cap and mix.
8. Use the 0.1 g spoon (0699) to add 0.1 g of *Iron Reagent #2 Powder (V-4451). Cap and shake vigorously for 30 seconds. Wait three minutes for maximum color development.
9. At the end of 3 minute waiting period, do not mix. Insert tube into chamber, close lid and select SCAN SAMPLE. Record result.
10. Press **OFF** button to turn spectrophotometer 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.

IRON

I,I0-PHENANTHROLINE METHOD • CODE 3668-SC

QUANTITY	CONTENTS	CODE
15 mL	*Acid Phenanthroline Indicator	*2776-E
5 g	*Iron Reducing Reagent	*2777-C
1	Spoon, 0.1 g, plastic	0699

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Most natural waters contain some iron. Its presence may vary from small traces to very large amounts in water which is contaminated by acid mine wastes. For domestic use, the concentration should not exceed 0.2 ppm and for some industrial applications not even a trace of iron can be tolerated. There are many means available for removing or reducing the iron content. Water softening resins are effective for removing small amounts of iron and special ion exchange materials are selective for iron removal. High concentrations of iron can be removed by such chemical processes as oxidation and lime or lime-soda softening. Because of the many means of removing or reducing the amount of iron in water, the particular method employed will depend largely on the form of iron which is present and the end use of the treated water.

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

RANGE: 0.00–4.50 ppm Iron

METHOD: Ferric iron is reduced to ferrous iron and subsequently forms a colored complex with phenanthroline for a quantitative measure of total iron.

SAMPLE HANDLING & PRESERVATION The sample container should be cleaned with acid and rinsed with deionized water. Addition of acid to adjust the sample to pH 2–3 will prevent deposition of iron on the container walls. Samples should be analyzed as soon as possible after collection since ferrous iron undergoes oxidation to ferric iron.

INTERFERENCES: Strong oxidizing agents, cyanide, nitrite, and phosphates, chromium, zinc in concentrations exceeding 10 times that of iron; cobalt and copper in excess of 5 mg/L, and nickel in excess of 2 mg/L. Bismuth, cadmium, mercury, , and silver precipitate phenanthroline.

PROCEDURE

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select PROGRAMMED TESTS.
3. Scroll to and select ALL TESTS (or another sequence containing 53 Iron Phen) from TESTING MENU.
4. Scroll to and select 53 Iron Phen from menu.
5. Rinse a clean tube (0290)with sample water. Fill to the 10 mL mark with sample.
6. Insert tube into chamber, close lid and select SCAN BLANK.
7. Remove the tube from Spectro. Use the 0.1 g spoon (0699) to add one measure of *Iron Reducing Reagent (2777). Cap and invert the tube 15–20 times to mix.
8. Remove the cap and add 6 drops of *Acid Phenanthroline Indicator (2776). Cap and invert the tube 4 times to mix reagents. Wait five minutes for maximum color development.
9. After five minutes, mix, insert tube into chamber, close lid and select SCAN SAMPLE. Record result.
10. Press **OFF** button to turn spectrophotometer 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.

IRON–UDV

BIPYRIDYL METHOD–UNIT DOSE VIALS • CODE 4315-H

QUANTITY	CONTENTS	CODE
1	*Iron Unit Dose Vials, 50 pouches	*4315-H

*WARNING: Reagents marked with an * are considered hazardous substances. To view or print a Material Safety Data Sheet (MSDS) for these reagents see MSDS CD or our web site. To obtain a printed copy, contact us by e-mail, phone or fax.

Equipment needed but not supplied:

STANDARD ACCESSORY PACKAGE • CODE 1961

1	Package of 3 Vials (empty)	0156
1	Syringe, 6 mL, plastic	1184
1	Foil Storage Bag	9467

Or:

ADVANCED ACCESSORY PACKAGE • CODE 1962

1	Pipettor	30528
1	Pipet Tip (0-5 mL)	30695
1	Cuvette Rack	31695
1	Package of 3 Vials (empty)	0156
1	Foil Storage Bag	9467

Most natural waters contain some iron. Its presence may vary from small traces to very large amounts in water which is contaminated by acid mine wastes. For domestic use, the concentration should not exceed 0.2 ppm and for some industrial applications not even a trace of iron can be tolerated. There are many means available for removing or reducing iron content. Water softening resins are effective for removing small amounts of iron and special ion exchange materials are selective for iron removal. High concentrations of iron can be removed by such chemical processes as oxidation and lime or lime-soda softening. Because of the many means of removing or reducing the amount of iron in water, the particular method employed will depend largely on the form of iron which is present and the end use of the treated water.

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

RANGE: 0.00–10.00 ppm

METHOD: Ferric iron is reduced to ferrous iron and subsequently forms a colored complex with for a quantitative measure of total iron.

SAMPLE HANDLING & PRESERVATION: The sample container should be cleaned with acid and rinsed with deionized water. Addition of acid to adjust the sample. The pH 2-3 will prevent deposition of iron on the container walls. Samples should be analyzed as soon as possible.

INTERFERENCES: Strong oxidizing agents interfere, as well as copper and cobalt in excess of 5.0 ppm.

PROCEDURE

Use 10 mm square cell adapter.

1. Press and hold **ON** button.
2. Scroll to and select `PROGRAMMED TESTS`.
3. Scroll to and select `ALL TESTS` (or another sequence containing `52 Iron-UDV`) from `TESTING MENU`.
4. Scroll to and select `52 Iron-UDV` from menu.
5. Rinse a clean vial (0156) with sample water.
6. Use the syringe (1184) to add 3 mL of sample to the vial.
7. Insert the vial into the chamber, close the lid and select `SCAN BLANK`.
8. Remove the vial from the Spectro.
9. Use the syringe (1184) to add 3 mL of sample to an *Iron UDV vial (4315).
10. Shake vigorously for 15 seconds.
11. Wait 2 minutes.
12. Invert vial 3 times to mix.

    ☑NOTE: If powder residue remains in the bottom of the vial after inverting, or air bubbles forms, invert vial once more and tap bottom of vial sharply once or twice to dislodge powder or bubbles. Mix.
13. Insert tube into chamber, close lid and select `SCAN SAMPLE`. Record result.
14. Press **OFF** button to turn the spectrophotometer 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.

UDVs from opened pouches should be used promptly. Store unused vials from opened pouches in the Foil Storage Bag (9467) to extend the shelf life of the reagent. Generally, UDVs stored in the bag should be used within 10 days if the humidity is less than 50% and within 5 days if humidity is greater than 50%. The Foil Storage Bag contains a desiccant pack with indicator. When the indicator in the window turns from blue to pink, the bag should be replaced.

LEAD

PAR METHOD • CODE 4031

QUANTITY	CONTENTS	CODE
250 mL	Ammonium Chloride Buffer	4032-K
15 mL	*Sodium Cyanide, 10%	*6565-E
30 mL	PAR Indicator	4033-G
30 mL	Stabilizing Reagent	4022-G
15 mL	DDC Reagent	4034-E
1	Syringe, 5 mL, plastic	0807
2	Pipet, 0.5 mL, plastic	0353

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The average concentration of lead is 0.003 ppm in streams and less than 0.1 ppm in groundwater. Lead in a water supply may come from mine and smelter discharges or from industrial waste. Lead is used in the production of batteries, solder, pigments, insecticides, ammunition and alloys. Tetraethyl Lead has been used for years as an anti-knock reagent in gasoline. Lead may also enter water supplies when corrosive water dissolves pipes, plumbing fixtures and materials containing lead. Lead accumulates in the body and is toxic by ingestion.

APPLICATION: Drinking and surface waters; domestic and industrial wastewaters.

RANGE: 0.00–5.00 Lead

METHOD: Lead and calcium ions form a red complex with PAR (4-(2'-pyridylazo)resorcinol), at a pH of about 10. When sodium diethyldithiocarbamate is added, the lead/PAR complex is destroyed leaving the calcium/PAR complex. The difference between the two measurements is due to the lead concentration.

SAMPLE HANDLING & PRESERVATION: Analyze sample as soon as possible. If sample must be stored, acidify with nitric acid to a pH of below 2.

INTERFERENCES: Calcium greater than 100 ppm (250 ppm $CaCO_3$) will interfere. Low concentrations of cerium, iron, manganese, magnesium, sulfur, tin, and EDTA will also interfere.

PROCEDURE

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select `PROGRAMMED TESTS`.
3. Scroll to and select `ALL TESTS` (or another sequence containing `54 Lead`) from `TESTING MENU`.
4. Scroll to and select `54 Lead` from menu.
5. Rinse a tube (0290) with sample water. Fill to 10 mL with sample.
6. Insert the tube into chamber, close lid and select `SCAN BLANK`.
7. Remove the tube from Spectro. Use the Syringe (0807) to remove 5mL of sample from tube. Discard remaining sample.
8. Add the 5 mL of sample in the syringe to the tube. Add 5 mL Ammonium Chloride Buffer (4032) to fill the tube to the 10 mL line. Swirl to mix.
9. Add 3 drops *Sodium Cyanide, 10% (6565). Swirl to mix.
10. Use the 0.5 mL pipet (0353) to add 0.5 mL PAR Indicator (4033). Swirl to mix.
11. Use the 0.5 mL pipet (0353) to add 0.5 mL Stabilizing Reagent (4022). Cap and mix.
12. Insert tube into chamber, close lid and select `SCAN SAMPLE`. Record result in ppm as Reading A.
13. Remove tube from Spectro. Add 3 drops DDC Reagent (4034). Cap and mix.
14. Insert tube into chamber, close lid and select `SCAN SAMPLE`. Record result in ppm as Reading B.
15. ppm Lead = Reading A–Reading B
16. Press **OFF** button to turn the spectrophotometer 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.

MANGANESE–LOW RANGE

PAN METHOD • CODE 3658-01-SC

QUANTITY	CONTENTS	CODE
4 x 30 mL	*Hardness Buffer Reagent	*4255-G
30 mL	*Manganese Indicator Reagent	*3956-G
15 mL	*Sodium Cyanide, 10%	*6565-E
1	Pipet, 0.5 mL, plastic	0369
1	Pipet, 1.0 mL, plastic	0354

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Manganese is present in ground water in the divalent state due to the lack of oxygen. In surface waters manganese may be in various oxidation states as soluble complexes or as suspended compounds. Manganese is rarely present in excess of 1 mg/L. It may cause an objectionable taste or cause staining problems in laundry, but manganese levels normally encountered in water seldom produce any health hazard.

Manganese is removed from water by various means including chemical precipitation, pH adjustment, aeration, superchlorination and the use of ion exchange resins.

APPLICATION: Drinking and surface waters; domestic and industrial wastewaters.

RANGE: 0.00–0.70 ppm Manganese

METHOD: PAN (1–(2–Pyridylazo)–2–Naphthol) forms a red complex with Manganese (Mn^{2+}) at a pH of 10 to 11.

SAMPLE HANDLING & PRESERVATION: Manganese may oxidize readily in neutral water and precipitate from solution. It may adhere to or be absorbed by container walls, especially glass. Acidified sample can be stored in plastic.

INTERFERENCES: None. Test is quite specific.

PROCEDURE

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select `PROGRAMMED TESTS`.
3. Scroll to and select `ALL TESTS` (or another sequence containing `55 Manganese L`) from `TESTING MENU`.
4. Scroll to and select `55 Manganese L` from menu.
5. Rinse a 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 Spectro. Use the 1.0 mL pipet (0354) to add 2.0 mL (two measures) of *Hardness Buffer Reagent (4255). Swirl to mix.
8. Add 2 drops of *Sodium Cyanide, 10% (6565). Cap and mix.
9. Use the 0.5 mL pipet (0369) to add 0.5 mL of *Manganese Indicator Reagent (3956). Cap and mix.
10. Immediately insert tube into chamber, close lid and select `SCAN SAMPLE`. Record result.
11. Press **OFF** button to turn spectrophotometer 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.

MANGANESE–HIGH RANGE

PERIODATE METHOD • CODE 3669-SC

QUANTITY	CONTENTS	CODE
10 g	Manganese Buffer Reagent	6310-D
15 g	*Manganese Periodate Reagent	*6311-E
1	Spoon, 0.1 g, plastic	0699
1	Spoon, 0.15 g, plastic	0727

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Manganese is present in ground water in the divalent state due to the lack of oxygen. In surface waters, manganese may be in various oxidation states as soluble complexes or as suspended compounds. Manganese is rarely present in excess of 1 mg/L. It may impart an objectionable taste or cause staining problems in laundry, but manganese levels normally encountered in water seldom produce any health hazards. Manganese is removed from water by various means, including chemical precipitation, pH adjustment, aeration, superchlorination and the use of ion exchange resins.

APPLICATION: Drinking and surface waters; domestic and industrial wastewaters.

RANGE: 0.0–15.0 ppm Manganese

METHOD: Periodate oxidizes soluble manganous compounds into permanganate.

SAMPLE HANDLING & PRESERVATION: Manganese may oxidize readily in a neutral water and precipitate from solution. It may adhere to or be absorbed by container walls, especially glass. Acidified samples can be stored in plastic.

INTERFERENCES: Reducing substances capable of reacting with periodate or permanganate must be removed or destroyed before the periodate oxidation is attempted.

PROCEDURE

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select `PROGRAMMED TESTS`.
3. Scroll to and select `ALL TESTS` (or another sequence containing `56 Manganese H`) from `TESTING MENU`.
4. Scroll to and select `56 Manganese H` from menu.
5. Rinse a 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 Spectro. Use the 0.1 g spoon (0699) to add two measures of Manganese Buffer Reagent (6310). Cap and mix until powder dissolves.
8. Use the 0.15 g spoon (0727) to add one measure of *Manganese Periodate Reagent (6311). Cap and shake for one minute. An undissolved portion of the reagent may remain in the bottom of the tube without adversely affecting the test results. Wait two minutes for maximum color development. Solution will turn pink if manganese is present.
9. At the end of the two minute waiting period, mix, insert tube into chamber, close lid and select `SCAN SAMPLE`. Record result.
10. Press **OFF** button to turn spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

MERCURY

TMK METHOD • CODE 4861

QUANTITY	CONTENTS	CODE
50	*TMK Tablets	*4862-H
2 x 250 mL	*Propyl Alcohol	*4863-K
250 mL	*Acetate Buffer	*4864-K
1	Tablet Crusher	0175
1	Test Tube, 10 mL, glass, w/cap	0778
1	Pipet, 1.0 mL, plastic	0354
1	Pipet, 0.5 mL, plastic	0353

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Mercury occurs in small amounts in soil, streams and groundwater. It is used in the production of amalgams, mirror coatings and measuring devices such as thermometers, barometers and manometers. Pharmaceuticals and paints contain mercury. It is also used in fungicides and pesticides and as a mold retardant on paper. Some forms of mercury are very toxic and can accumulate in the aquatic food chain.

APPLICATION: Drinking and surface waters; domestic and industrial wastewater.

RANGE: 0.00–1.50 ppm Mercury

METHOD: Mercuric ions (Hg^{+2}) form a colored complex with 4, 4'-bis (dimethylamino) thiobenzophenone (Thio-Michler's ketone, TMK) at pH 3.

SAMPLE HANDLING & PRESERVATION: Analyze sample as soon as possible. If sample must be stored, treat with HNO_3 to reduce th pH to less than 2 and store in a glass container.

INTERFERENCES: Palladium and other noble metals (gold, platinum, rhodium, iridium, ruthenium), iodide and reducing agents such as hydroxylamine hydrochloride, ascorbic acid, sulfite and thiosulfate. Interference due to silver is eliminated if chloride is present.

PREPARATION OF *TMK INDICATOR

☑NOTE: Prepare *TMK Indicator daily. Keep out of direct sunlight.

1. Fill test tube (0778) to the 10 mL line with *Propyl Alcohol (4863).
2. Add one *TMK Tablet (4862).
3. Use tablet crusher (0175) to completely crush tablet.
4. Cap and mix. Shake vigorously for 30 seconds.

PROCEDURE

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll and select `PROGRAMMED TESTS`.
3. Scroll and select `ALL TESTS` (or another sequence containing `57 Mercury`) from `TESTING MENU`.
4. Scroll to and select `57 Mercury` from menu.
5. Rinse a tube (0290) with sample water. Fill to 10 mL with sample.
6. Insert the tube into chamber, close lid and select `SCAN BLANK`.
7. Remove the tube from spectrophotometer.
8. Use the 1.0 mL pipet (0354) to add 3 mL of *Acetate Buffer (4864). Cap and mix.
9. Use the 0.5 mL pipet (0353) to add 0.5 mL of prepared *TMK Indicator. Cap and mix.
10. Wait one minute.
11. Insert tube into chamber, close lid and select `SCAN SAMPLE`. Record result as ppm Mercury.
12. Press **OFF** button to turn the spectrphotometer 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 using distilled or deionized water. This test result is the reagent blank. Subtract the reagent blank results from all subsequent test results of unknown samples. It is recommended that a reagent blank be determined each time *TMK Indicator is prepared.

MOLYBDENUM

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

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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 waters.

RANGE: 0.0–15.0 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

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select `PROGRAMMED TESTS`.
3. Scroll to and select `ALL TESTS` (or another sequence containing `61 Molybdenum-HR`) from `TESTING MENU`.
4. Scroll to and select `61 MOLYBDENUM-HR` from menu.
5. Fill clean tube (0290) to 10 mL line with sample water.
6. Insert tube into chamber, close lid and select `SCAN BLANK`.
7. Remove tube from Spectro. Use a 1.0 mL pipet (0372) to add 1.0 mL of *Mo Buffer (3997). Cap and mix.
8. Use a second 1.0 mL pipet (0372) to add 1.0 mL of *Molybdenum Oxidizing Reagent (6485). Cap and mix.
9. Use 0.05 g spoon (0696) to add one measure of Molybdenum Indicator Powder (6486). Cap and mix until powder dissolves. Solution will turn yellow if molybdenum is present.
10. Insert tube into chamber, close lid and select `SCAN SAMPLE`. Record result.
11. Press **OFF** button to turn spectrophotometer 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 an * are considered hazardous substances. To view or print a Material Safety Data Sheet (MSDS) for these reagents see MSDS CD or our web site. To obtain a printed copy, contact us by e-mail, phone or fax.

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 wastewaters.

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

Use universal sample holder.

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 spectrophotometer turns on.
10. Scroll to and select `PROGRAMMED TESTS`.
11. Scroll to and select `ALL TESTS` (or another sequence containing `63 Nickel`) from `TESTING MENU`.
12. Scroll to and select `63 Nickel` from menu.
13. Insert the blank into chamber, close lid and select `SCAN BLANK`.
14. Insert test sample into chamber, close lid and select `SCAN SAMPLE`. Record result.
15. Press **OFF** button to turn spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

NITRATE

ZINC REDUCTION • CODE 3689-SC

QUANTITY	CONTENTS	CODE
50	*Nitrate Spectrophotometic Grade Tablets	*3881-H
1	Tablet Crusher	0175

*WARNING: Reagents marked with an * are considered hazardous substances. To view or print a Material Safety Data Sheet (MSDS) for these reagents see MSDS CD or our web site. To obtain a printed copy, contact us by e-mail, phone or fax.

Nitrogen is essential for plant growth, but excessive amounts in water supplies can result in nutrient pollution. Nitrates, in conjunction with phosphate, stimulate the growth of algae creating water quality problems. Nitrogen compounds may enter water as nitrates or be converted to nitrates from agricultural fertilizers, sewage, industrial and packing house wastes, drainage from livestock feeding areas and manure. Nitrates in large amounts in drinking water can cause "blue baby syndrome" (methemoglobenemia) in infants in less than 6 months of age and other health problems. US Public Health Service Drinking Water Standards state that 44 ppm nitrate should not be exceeded. To the sanitary and industrial engineer, concentrations of less than 4 ppm are acceptable.

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

RANGE: 0–60 ppm Nitrate

METHOD: Zinc is used to reduce nitrate to nitrite. The nitrite that was originally present, plus the reduced nitrate, reacts with chromotropic acid to form a red color in proportion to the amount of nitrite in the sample.

SAMPLE HANDLING & PRESERVATION: Analysis should be made as soon as possible. If analysis cannot be made within 24 hours, the sample should be refrigerated at 4°C. When samples must be stored for more than 24 hours, add 2 mL of concentrated sulfuric acid per liter of sample. For best results, the analysis for nitrate should be determined at temperatures between 20°C and 25°C.

INTERFERENCES: Nitrite interferes at all concentrations. Strong oxidizing and reducing substances interfere. Low results might be obtained for samples that contain high concentrations of copper and iron.

PROCEDURE

Use universal sample holder

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select `PROGRAMMED TESTS.`
3. Scroll to and select `ALL TESTS` (or another sequence containing `66 Nitrate-TT`) from `TESTING MENU`.
4. Scroll to and select `66 Nitrate-TT` from menu.
5. Rinse a tube (0290) with sample water. Fill to 10 mL with sample.
6. Insert the tube into chamber, close lid and select `SCAN BLANK`.
7. Remove the tube from Spectro.
8. Add one *Nitrate Spectrophotometric Grade Tablet (3881).
9. Use Tablet Crusher (0175) to crush tablet.
10. Cap tube.
11. Invert tube 60 times per minute for 2 minutes. (One inversion equals 180°).
12. Wait 5 minutes. Do **NOT** mix.
13. Insert tube into chamber, close lid and select `SCAN SAMPLE`. Record result in ppm nitrate.
14. Press **OFF** button to turn the spectrophotometer 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.

To convert nitrate (NO_3) results to nitrate-nitrogen (NO_3-N), divide by 4.4.

NITRATE-NITROGEN–LOW RANGE

CADMIUM REDUCTION METHOD • CODE 3649-SC

QUANTITY	CONTENTS	CODE
2 x 60 mL	*Mixed Acid Reagent	*V-6278-H
5 g	*Nitrate Reducing Reagent	*V-6279-C
1	Spoon, 0.1 g, plastic	0699
1	Dispenser Cap	0692

*WARNING: Reagents marked with an * are considered hazardous substances. To view or print a Material Safety Data Sheet (MSDS) for these reagents see MSDS CD or our web site. To obtain a printed copy, contact us by e-mail, phone or fax.

Nitrogen is essential for plant growth, but the presence of excessive amounts in water supplies presents a major pollution problem. Nitrogen compounds may enter water as nitrates or be converted to nitrates from agricultural fertilizers, sewage, industrial and packing house wastes, drainage from livestock feeding areas, farm manures and legumes. Nitrates in large amounts can cause "blue babies" (methemoglobinemia) in infants less than six months of age. Nitrate concentration is an important factor to be considered in livestock products, where, in addition to causing methemoglobinemia, it is responsible for many other problems. Nitrates in conjunction with phosphate stimulate the growth of algae with all of the related difficulties associated with excessive algae growth.

U.S. Public Health Service Drinking Water Standards state that 10 ppm nitrate nitrogen should not be exceeded. To the sanitary and industrial engineer, concentrations of less than 1 ppm are acceptable.

APPLICATION:	Drinking, surface, and saline waters; domestic and industrial waters.
RANGE:	0.00–3.00 ppm Nitrate Nitrogen
METHOD:	Powdered cadmium is used to reduce nitrate to nitrite. The nitrite that is originally present plus reduced nitrate is determined by diazotization of sulfanilamide and nitrite followed by coupling with N-(1 naphthyl)-ethylenediamine dihydrochloride to form a highly colored azo dye which is measured colorimetrically.
SAMPLE HANDLING & PRESERVATION:	Analysis should be made as soon as possible. If analysis cannot be made within 24 hours, the sample should be preserved by refrigeration at 4°C. When samples must be stored for more than 24 hours, they can be preserved by adding 2 mL of concentrated sulfuric acid per liter of sample. For best results, the analysis for nitrate should be determined at temperatures between 20°C and 25°C.
INTERFERENCES:	Nitrite interferes at all levels. Use the following equation to compensate for nitrite interferences: Test result (ppm)–(Nitrite-N(ppm) x 5.5) = true Nitrate-N reading. Strong oxidizing and reducing substances interfere. Low results might be obtained for samples that contain high concentrations of iron and copper.

PROCEDURE

Use universal sample holder.

☑NOTE: Place Dispenser Cap (0692) on *Mixed Acid Reagent (V-6278). Save this cap for refill reagents.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select `PROGRAMMED TESTS`.
3. Scroll to and select `ALL TESTS` (or another sequence containing `64 Nitrate-N LR`) from `TESTING MENU`.
4. Scroll to and select `64 Nitrate-N LR` from menu.
5. Rinse a clean tube (0290) with sample water. Fill to 10 mL line with sample.
6. Insert tube into chamber, close lid and select `SCAN BLANK`.
7. Remove tube from Spectro and pour off 5 mL into graduated cylinder or similar. Discard the remaining sample.
8. Pour the 5 mL sample from a graduated cylinder or similar into the tube. Use the graduated cylinder or similar to measure 5 mL of *Mixed Acid Reagent (V-6278) and add to tube. Cap and mix. Wait 2 minutes before proceeding to Step 9.
9. Use the 0.1 g spoon (0699) to add two measures of *Nitrate Reducing Reagent (V-6279). Cap.
10. Hold tube by index finger and thumb and mix by inverting approximately 50-60 times a minute for four minutes. Wait 10 minutes for maximum color development.

    ☑NOTE: At end of waiting period an undissolved portion of Nitrate Reducing Reagent may remain in bottom of the tube without affecting results.

11. At the end of the 10 minute waiting period, mix, insert tube into chamber, close lid and select `SCAN SAMPLE`. Record result.
12. Press **OFF** button to turn spectrophotometer 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.

To convert Nitrate Nitrogen (NO_3–N) results to ppm Nitrate (NO_3), multiply by 4.4.

NITRITE

ZINC REDUCTION • CODE 3694-SC

QUANTITY	CONTENTS	CODE
50	*Nitrite Spectrophotometric Grade Tablets	*3886-H
1	Tablet Crusher	0175

*WARNING: Reagents marked with an * are considered hazardous substances. To view or print a Material Safety Data Sheet (MSDS) for these reagents see MSDS CD or our web site. To obtain a printed copy, contact us by e-mail, phone or fax.

Nitrite represents an intermediate stage of the nitrogen cycle, usually resulting from the bacterial decomposition of compounds containing organic nitrogen. Under aerobic conditions bacteria oxidize ammonia to nitrites; and under anaerobic conditions, bacteria reduce nitrates to nitrites. Nitrites are often used as food preservatives. The nitrite concentration of drinking water rarely exceeds 0.1 ppm.

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

RANGE: 0.00–1.25 ppm Nitrite

METHOD: The compound formed by diazotization of sulfanilamide and nitrite is coupled with N-(1-naphthyl)-ethylenediamine to produce a reddish purple color in proportion to the nitrite concentration.

SAMPLE HANDLING & PRESERVATION: Samples should be analyzed as soon as possible. They may be stored for 24 to 48 hours at 4°C.

INTERFERENCES: There are few known interfering substances at concentrations at less than 1000 times the nitrite-nitrogen concentration; however, the p[presence of strong oxidizing agents or reductants may readily affect nitrite concentrations.

PROCEDURE

Use universal sample holder

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select `PROGRAMMED TESTS.`
3. Scroll to and select `ALL TESTS` (or another sequence containing `69 Nitrite-TT`) from `TESTING MENU`.
4. Scroll to and select `69 Nitrite-TT` from menu .
5. Rinse a tube (0290) with sample water. Fill to 10 mL with sample.
6. Insert the tube into chamber, close lid and select `SCAN BLANK`.
7. Remove the tube from Spectro.
9. Add one *Nitrite Spectrophotometric Grade Tablet (3886).
10. Use Tablet Crusher (0175) to crush tablet.
11. Cap tube.
12. Shake vigorously for 20 seconds.
13. Wait 2 minutes.
14. Insert tube into chamber, close lid and select `SCAN SAMPLE`. Record result in ppm nitrite.
15. Press **OFF** button to turn the spectrophotometer 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.

To convert nitrite (NO_2) results to nitrite-nitrogen (NO_2–N), divide results by 3.3.

NITRITE-NITROGEN–LOW RANGE

DIAZOTIZATION METHOD • CODE 3650-SC

QUANTITY	CONTENTS	CODE
2 x 60 mL	*Mixed Acid Reagent	*V-6278-H
5 g	*Color Developing Reagent	*V-6281-C
1	Spoon, 0.1 g, plastic	0699
1	Dispenser Cap	0692

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Nitrite represents an intermediate state in the nitrogen cycle, usually resulting from the bacterial decomposition of compounds containing organic nitrogen. Under aerobic conditions bacteria oxidize ammonia to nitrites; and under anaerobic conditions, bacteria reduce nitrates to nitrites. Nitrites are often used as preservatives when added to certain foods.

The nitrite concentration of drinking water rarely exceeds 0.1 ppm (mg/L).

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

RANGE: 0.000–0.800 ppm Nitrite-Nitrogen

METHOD: The compound formed by diazotization of sulfanilamide and nitrite is coupled with N–(1–naphthyl)–ethylenediamine to produce a reddish-purple color, which is read colorimetrically.

SAMPLE HANDLING & PRESERVATION: Samples should be analyzed as soon as possible. They may be stored for 24 to 48 hours at 4°C.

INTERFERENCES: There are few known interfering substances at concentration less than 1000 times the nitrite-nitrogen concentration; however, the presence of strong oxidants or reductants may readily affect nitrite concentrations. High alkalinity (above 600 mg/L) will give low results due to a shift in pH.

PROCEDURE

Use universal sample holder.

☑NOTE: Place Dispenser Cap (0692) on *Mixed Acid Reagent (V-6278). Save this cap for refill reagents.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select `PROGRAMMED TESTS`.
3. Scroll to and select `ALL TESTS` (or another sequence containing `67 Nitrite-N LR`) from `TESTING MENU`.
4. Scroll to and select `67 Nitrite-N LR` from menu.
5. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
6. Insert tube into chamber, close lid and select `SCAN BLANK`.
7. Remove tube from Spectro and pour off 5 mL into a graduated cylinder or similar. Discard the remaining sample.
8. Pour the 5 mL sample from the graduated cylinder into the colorimeter tube. Use graduated cylinder or similar to measure 5 mL of *Mixed Acid Reagent (V-6278) and add to tube. Cap and mix.
9. Use the 0.1 g spoon (0699) to add two measures of *Color Developing Reagent (V-6281). Cap and mix by gently inverting for 1 minute. Wait 5 minutes for maximum color development.
10. At the end of the 5 minute waiting period, mix, insert tube into chamber, close lid and select `SCAN SAMPLE`. Record result.
11. Press **OFF** button to turn spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

☑NOTE: To convert nitrite-nitrogen (NO_2–N) results to ppm nitrite (NO_2), multiply results by 3.3.

NITROGEN, TOTAL

Chromotropic Acid with Persulfate Digestion Method • Code 4026

QUANTITY	CONTENTS	CODE
25	Total Nitrogen Hydroxide Reagent Tubes	4040-G
5 g	*Digestion Reagent Powder	4036-C
60 mL	Deionized Water	*5115PS-H
5 g	*Total Nitrogen Reagent A Powder	*4041-C
30	*Total Nitrogen Reagent B Tablets	*4042
25	*Total Nitrogen Acid Reagent Tubes	*4043-G
2	Spoon, 0.15 g, plastic	0727
4	Pipets, 1.0 mL, plastic	0354
2	Funnels, plastic	0459

*WARNING: Reagents marked with an * are considered hazardous substances. To view or print a Material Safety Data Sheet (MSDS) for these reagents see MSDS CD or our web site. To obtain a printed copy, contact us by e-mail, phone or fax.

Note: for greater accuracy, use laboratory grade pipets.

Equipment needed but not supplied:

1	COD Adapter	5-0087
1	COD Reactor, 12 tubes, 110V	5-0102
or 1	COD Reactor, 12 tubes, 230V	5-0102-EX

Optional Equipment:

4	Pipet, Measuring, 1.0 mL	2-2110
1	Pipet Bulb	2-2164
1	Wipes	2-2069
1	Test Tube Rack	23371
1	Timer	9371-W13
1	Test Tube Holder	2-2190

Nitrogen is essential for plant growth, but the presence of excessive amounts in water supplies presents a major pollution problem. Nitrogen compounds may enter water as nitrates or be converted to nitrates from agricultural fertilizers, sewage, industrial and packing house wastes, drainage from livestock feeding areas, farm manures and legumes. Nitrates in large amounts can cause "blue babies" (methemoglobinemia) in infants less than six months of age. Nitrate concentration is an important factor to be considered in livestock products, where, in addition to causing methemoglobinemia, it is responsible for many other problems. Nitrates in conjunction with phosphate stimulate the growth of algae with all of the related difficulties associated with excessive algae growth.

U.S. Public Health Service Drinking Water Standards state that 10 ppm nitrate nitrogen should not be exceeded. To the sanitary and industrial engineer, concentrations of less than 1 ppm are acceptable.

APPLICATION:	Drinking, surface, saline, domestic and industrial waters.
RANGE:	0–25 mg/L Total Nitrogen
METHOD:	All forms of nitrogen are converted to nitrate by an alkaline persulfate digestion. Interference from halogen oxides is eliminated by the addition of sodium metabisulfite. Nitrate in acid reacts with chromotropic acid to form a yellow color in proportion to the amount of nitrate in the treated sample.
SAMPLE HANDLING AND PRESERVATION:	If the sample can not be analyzed immediately, the sample should be preserved by adjusting the pH to 2 or less with concentrated sulfuric acid and refrigerated at 4°C. Warm the sample to room temperature and neutralize with 5.0 N sodium hydroxide before analyzing.
INTERFERENCES:	Bromide (>60 ppm) and chloride (>1000 ppm) will have a positive interference.

PROCEDURE

Use universal sample holder

1. Preheat COD reactor to 100 ±2°C. Follow safety precautions.
2. Remove caps from two *Total Nitrogen Hydroxide Reagent Tubes (4040).
3. Use a 0.15 g spoon (0727) and a funnel (0459) to add one level measure of *Digestion Reagent Powder (4036) to each tube. Tap funnel to dispense powder completely.
4. Use a 1.0 mL pipet (0354) to add 2.0 mL of Deionized Water (5115PS), or organic-free water, to one tube. This is the blank.
5. Use another 1.0 mL pipet (0354) to add 2.0 mL of sample to the other tube. This is the sample.
6. Cap both tubes and shake vigorously for 30 seconds.
7. Place the tubes in the COD reactor for 30 minutes.
8. After exactly 30 minutes, turn the reactor off. Carefully remove the tubes from the reactor and allow them to cool to room temperature.
9. At the end of the cooling period, press **ON** button until spectrophotometer turns on.
10. Scroll to and select `PROGRAMMED TESTS` from the menu.
11. Scroll to and select `ALL TESTS` (or another sequence containing `62 Nitrogen T`) from `PROGRAMMED TESTS` menu.
12. Scroll to and select `62 Nitrogen T` from the menu.
13. Carefully remove caps from the digested tubes.
14. Use a 0.15 g spoon (0727) and a funnel (0459) to add one level measure of *Total Nitrogen Reagent A Powder (4041). Tap funnel to dispense powder completely. Cap the tubes and shake for 15 seconds.
15. Wait 3 minutes.
16. Remove the caps from the tubes. Add one *Total Nitrogen Reagent B Tablet (4042) to each tube. Cap the tubes and shake for 45 seconds or until the tablet disintegrates.
17. Wait 2 minutes.
18. Remove the caps from the reacted tubes. Carefully remove the caps from two *Total Nitrogen Acid Reagent Tubes (4043). **CAUTION:** Tubes contain a strong acid.
19. Use another 1.0 mL pipet (0354) to add 2 mL of digested, treated blank to one Total Nitrogen Acid Reagent Tube. This is the blank.
20. Use another 1.0 mL pipet (0354) to add 2 mL of digested, treated sample to the other Total Nitrogen Acid Reagent Tube. This is the sample.
21. Cap the tubes and invert 10 times to mix. **CAUTION:** The tubes will be hot.

    ☑NOTE: Invert slowly and completely for accurate results. Hold tubes with caps up. Invert the tube and wait for the air bubble to flow to the bottom of the tube. Turn the tube upright and wait for the air bubble to return to the top of the tube. This is one inversion.
22. Wait 5 minutes.

23. Wipe the tubes with a damp towel to remove fingerprints and smudges. Wipe with a dry towel.
24. Insert the blank tube into the chamber. Select SCAN BLANK. Remove the blank tube from the spectrophotometer.
25. Insert the sample tube into the chamber. Select SCAN SAMPLE. Record the result as Total Nitrogen in mg/L N.
26. Press **OFF** button to turn the spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

☑NOTE: For greater accuracy, use laboratory grade pipets. To order reagent refills, order code R-4026.

OXYGEN SCAVENGERS

DEHA (Diethylhydroxylamine), Carbohydrazide, Erythorbic Acid, Hydroquinone, Methylethylketoxime

IRON REDUCTION METHOD • CODE 4857

QUANTITY	CONTENTS	CODE
15 mL	*DEHA Reagent #1	*4791-E
15 mL	*DEHA Reagent #2	*4792-E
15 mL	*DEHA Reagent #3	*4793-E

*WARNING: Reagents marked with an * are considered hazardous substances. To view or print a Material Safety Data Sheet (MSDS) for these reagents see MSDS CD or our web site. To obtain a printed copy, contact us by e-mail, phone or fax.

Oxygen can lead to corrosion in many parts of a boiler. Oxygen scavengers are added to the water to eliminate oxygen and thus decrease the chance of corrosion. Diethylhydroxylamine (DEHA) is a volatile oxygen scavenger used in boilers. It can also passivate steel and has a low toxicity.

APPLICATION: Boilers

RANGE: 0.000–0.700 ppm DEHA (Diethylhydroxylamine)
0.000–0.900 ppm Carbohydrazide
0.00–3.00 ppm Erythorbic Acid
0.00–1.80 ppm Hydroquinone
0.00–3.00 ppm Methylethylketoxime

METHOD: Ferric iron is reduced to ferrous iron by oxygen scavengers in proportion to the concentration in the sample. The resulting ferrous iron reacts with an indicator to produce a purple color.

SAMPLE HANDLING & PRESERVATION: Analyze samples immediately. Rinse sample containers and glassware with 1:1 hydrochloric acid to avoid iron contamination.

INTERFERENCES: Other oxygen scavengers, such as DEHA, carbohydrazide, erythorbic acid, hydroquinone and methylethylketoxime will interfere. Stray light and substances which complex iron or reduce ferric iron will also interfere.

DEHA PROCEDURE

Use universal sample holder

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select PROGRAMMED TESTS.
3. Scroll to and select ALL TESTS (or another sequence containing 38 DEHA) from TESTING MENU.
4. Scroll to and select 38 DEHA from menu.
5. Rinse a tube (0290) with sample water. Fill to 10 mL with sample.
6. Insert the tube into chamber, close lid and select SCAN BLANK.
7. Remove the tube from spectrophotometer.
8. Add 3 drops of *DEHA Reagent #1 (4791). Swirl to mix.
9. Add 3 drops of *DEHA Reagent #2 (4792). Swirl to mix.
10. Add 3 drops of *DEHA Reagent #3 (4793). Invert 3 times to mix.
11. Insert the tube into chamber. Close lid.
12. Wait 15 minutes. Do not open the lid during the waiting time. The reaction is photosensitive.
13. Remove tube from chamber. Invert 2 times to mix.
14. Immediately insert tube into chamber, close lid and select SCAN SAMPLE. Read within 30 seconds. Record result in ppm DEHA.
15. Press **OFF** button to turn the spectrophotometer 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.

CARBOHYDRAZIDE PROCEDURE

Use universal sample holder

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select `PROGRAMMED TESTS`.
3. Scroll to and select `ALL TESTS` (or another sequence containing `14 c-hydrazide`) from `TESTING MENU`.
4. Scroll to and select `14 c-hydrazide` from menu.
5. Rinse a tube (0290) with sample water. Fill to 10 mL with sample.
6. Insert the tube into chamber, close lid and select `SCAN BLANK`.
7. Remove the tube from spectrophotometer.
8. Add 3 drops of *DEHA Reagent #1 (4791). Swirl to mix.
9. Add 3 drops of *DEHA Reagent #2 (4792). Swirl to mix.
10. Add 3 drops of *DEHA Reagent #3 (4793). Invert 3 times to mix.
11. Insert the tube into chamber. Close lid.
12. Wait 15 minutes. Do not open the lid during the waiting time. The reaction is photosensitive.
13. Remove tube from chamber. Invert 2 times to mix.
14. Immediately insert tube into chamber, close lid and select `SCAN SAMPLE`. Read within 30 seconds. Record result in ppm carbohydrazide.
15. Press **OFF** button to turn the spectrophotometer 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.

ERYTHORBIC ACID PROCEDURE

Use universal sample holder

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select PROGRAMMED TESTS.
3. Scroll to and select ALL TESTS (or another sequence containing 40 E-thorbic A) from TESTING MENU.
4. Scroll to and select 40 E-thorbic A from menu.
5. Rinse a tube (0290) with sample water. Fill to 10 mL with sample.
6. Insert the tube into chamber, close lid and select SCAN BLANK.
7. Remove the tube from spectrophotometer.
8. Add 3 drops of *DEHA Reagent #1 (4791). Swirl to mix.
9. Add 3 drops of *DEHA Reagent #2 (4792). Swirl to mix.
10. Add 3 drops of *DEHA Reagent #3 (4793). Invert 3 times to mix.
11. Insert the tube into chamber. Close lid.
12. Wait 15 minutes. Do not open the lid during the waiting time. The reaction is photosensitive.
13. Remove tube from chamber. Invert 2 times to mix.
14. Immediately insert tube into chamber, close lid and select SCAN SAMPLE. Read within 30 seconds. Record result in ppm erythorbic acid.
15. Press **OFF** button to turn the spectrophotometer 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.

HYDROQUINONE PROCEDURE

Use universal sample holder

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select `PROGRAMMED TESTS`.
3. Scroll to and select `ALL TESTS` (or another sequence containing `49 H-quinone`) from `TESTING MENU`.
4. Scroll to and select `49 H-quinone` from menu.
5. Rinse a tube (0290) with sample water. Fill to 10 mL with sample.
6. Insert the tube into chamber, close lid and select `SCAN BLANK`.
7. Remove the tube from spectrophotometer.
8. Add 3 drops of *DEHA Reagent #1 (4791). Swirl to mix.
9. Add 3 drops of *DEHA Reagent #2 (4792). Swirl to mix.
10. Add 3 drops of *DEHA Reagent #3 (4793). Invert 3 times to mix.
11. Insert the tube into chamber. Close lid.
12. Wait 15 minutes. Do not open the lid during the waiting time. The reaction is photosensitive.
13. Remove tube from chamber. Invert 2 times to mix.
14. Immediately insert tube into chamber, close lid and select `SCAN SAMPLE`. Read within 30 seconds. Record result in ppm hydroquinone.
15. Press **OFF** button to turn the spectrophotometer 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.

METHYLETHYLKETOXIME PROCEDURE

Use universal sample holder

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select `PROGRAMMED TESTS`.
3. Scroll to and select `ALL TESTS` (or another sequence containing `58 m-e-ketoxim`) from `TESTING MENU`.
4. Scroll to and select `58 m-e-ketoxim` from menu.
5. Rinse a tube (0290) with sample water. Fill to 10 mL with sample.
6. Insert the tube into chamber, close lid and select `SCAN BLANK`.
7. Remove the tube from spectrophotometer.
8. Add 3 drops of *DEHA Reagent #1 (4791). Swirl to mix.
9. Add 3 drops of *DEHA Reagent #2 (4792). Swirl to mix.
10. Add 3 drops of *DEHA Reagent #3 (4793). Invert 3 times to mix.
11. Insert the tube into chamber. Close lid.
12. Wait 15 minutes. Do not open the lid during the waiting time. The reaction is photosensitive.
13. Remove tube from chamber. Invert 2 times to mix.
14. Immediately insert tube into chamber, close lid and select `SCAN SAMPLE`. Read within 30 seconds. Record result in ppm methylethylketoxime.
15. Press **OFF** button to turn the spectrophotometer 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.

OZONE

INDIGO METHOD • CODE 365I-SC

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

*WARNING: Reagents marked with an * are considered hazardous substances. To view or print a Material Safety Data Sheet (MSDS) for these reagents see MSDS CD or our web site. To obtain a printed copy, contact us by e-mail, phone or fax.

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

APPLICATION: Drinking water; swimming pool water.

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

Use universal sample holder.

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 spectrophotometer turns on.
10. Scroll to and select `PROGRAMMED TESTS`.
11. Scroll to and select `ALL TESTS` (or another sequence containing `71 OZONE-LR`) from `TESTING MENU`.
12. Scroll to and select `71 OZONE-LR` from menu.
13. Insert the **Reagent Blank** tube into chamber, close lid and select `SCAN BLANK`.
14. Insert reacted **Sample Tube** into chamber, close lid and select `SCAN SAMPLE`. Record result.
15. Press **OFF** button to turn spectrophotometer 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

Use universal sample holder.

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 spectrophotometer turns on.
10. Scroll to and select `PROGRAMMED TESTS`.
11. Scroll to and select `ALL TESTS` (or another sequence containing `72 OZONE-HR`) from `TESTING MENU`.
12. Scroll to and select `72 OZONE-HR` from menu.
13. Insert the **Reagent Blank** tube into chamber, close lid and select `SCAN BLANK`.
14. Insert reacted **Sample Tube** into chamber, close lid and select `SCAN SAMPLE`. Record result.
15. Press **OFF** button to turn spectrophotometer 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.

pH

COLORIMETRIC METHOD • CODE 3700-SC

QUANTITY	CONTENTS	CODE
60 mL	Chlorphenol Red Indicator	V-2209-H
60 mL	Phenol Red Indicator	V-2304-H
60 mL	Thymol Blue Indicator	V-2213-H
3	Pipets, 0.5 mL, plastic w/caps	0369

The term pH (always written with a lower case p and an upper case H) is correctly defined as the negative logarithm of the hydrogen ion concentration. More simply, the term pH can be considered to be an index of the amount of hydrogen ion present in a substance, or is a measure of the acidity of the substance. This index is important as it can be used to quickly identify the acid, neutral or alkaline (basic) nature of materials. Acidic substances have a pH less than 7.0, neutral substances have a pH equal to 7.0 and alkaline substances have a pH greater than 7.0.

Most natural waters have pH values from pH 5.0 to pH 8.5. Acidic, freshly fallen rain water may have a pH value of pH 5.5 to pH 6.0. When it reacts with soils and minerals containing weakly alkaline materials, the hydroxyl ion concentration will increase and the hydrogen ion concentration will decrease. Then the water may become slightly alkaline with a pH of 8.0 to 8.5. Natural sea water has a pH value of 8.1, and changes from this value indicate that water from an inland source is entering the body of sea water.

Waters more acidic than pH 5.0 and more alkaline than pH 8.5 to 9.0 should be viewed with suspicion. Mine drainage and acidic industrial wastes are the principal factors in increasing the acidity of water, and alkaline industrial wastes are the cause of high pH values.

Because pH measurements can be made so simply, and because they can tell so much about the past and future reactions of water, they are routinely made in water quality studies. Sudden changes in pH values serve as warning signals that water quality may be adversely affected through the introduction of contaminants.

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

METHOD: The various pH indicators exhibit a specific color change over a narrow pH range. The color changes are measured colorimetrically.

SAMPLE HANDLING & PRESERVATION: Sample should be analyzed immediately after collection.

INTERFERENCES: Sample color and turbidity interfere with the colorimetric pH measurement. Color interference may be removed by standardizing the instrument with the original water sample. Two drops of 0.1N sodium thiosulfate per 100 mL of sample will eliminate chlorine interference.

INDICATOR, RANGE, & TEST NAME:

pH Indicator	***pH***	***SMART Spectro Test Name***
Chlorphenol Red	5.0–7.0	74 pH CPR
Phenol Red	6.6–8.4	75 pH PR
Thymol Blue	8.0–9.5	76 pH TB

PROCEDURE

Use universal sample holder.

1. Use *Indicator, Range, & Test Name* chart to select the indicator, corresponding to anticipated pH range and to determine corresponding test name to select from spectrophotometer menu.
2. Press and hold **ON** button until spectrophotometer turns on.
3. Scroll to and select `PROGRAMMED TESTS`.
4. Scroll to and select `ALL TESTS` (or another sequence containing the appropriate pH test name) from `TESTING MENU`.
5. Scroll to and select the appropriate pH test name 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 Spectro. Use the 0.5 mL pipet (0369) to add exactly 0.5 mL of the pH indicator for the chosen range. Cap and mix.
9. Insert tube into chamber, close lid and select `SCAN SAMPLE`. Record result.
10. Press **OFF** button to turn spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

PHENOLS

AMINOANTIPYRINE METHOD • CODE 3652-SC

QUANTITY	CONTENTS	CODE
5 g	Aminoantipyrine Reagent	7825-C
30 mL	*Ammonium Hydroxide Solution	*7826-G
2 x 60 mL	*Potassium Ferricyanide Solution	*7827-H
1	Spoon, 0.1 g, plastic	0699
1	Pipet, plain, plastic	0352
1	Pipet, 1.0 mL, plastic	0354

*WARNING: Reagents marked with an * are considered hazardous substances. To view or print a Material Safety Data Sheet (MSDS) for these reagents see MSDS CD or our web site. To obtain a printed copy, contact us by e-mail, phone or fax.

Phenols may occur in domestic and industrial waste waters and in drinking water supplies. Chlorination of waters containing phenols may produce odiferous and objectionable tasting chlorophenols. Natural waters seldom contain more than 1 mg/L phenol.

Phenols may be removed from water by various treatment processes including chlorination and activated carbon absorption.

APPLICATION: Drinking and surface waters; domestic and industrial wastewaters.

RANGE: 0.00–6.00 ppm Phenol

METHOD: 4-Aminoantipyrine is oxidized in the presence of all ortho- and meta- substituted phenols to form a colored complex in proportion to the amount of phenol present.

SAMPLE HANDLING & PRESERVATION: Phenols are subject to biological and chemical oxidation. Samples should be analyzed within 4 hours after collection. If sample cannot be analyzed within 4 hours it can be preserved by acidification with phosphoric acid to pH 4.0.

INTERFERENCES: Oxidizing and reducing chemicals, alkaline pH values, and phenol decomposing bacteria may interfere with the test.

PROCEDURE

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select `PROGRAMMED TESTS`.
3. Scroll to and select `ALL TESTS` (or another sequence containing `77 Phenol`) from `TESTING MENU`.
4. Scroll to and select `77 Phenol` from menu.
5. Rinse a clean tube (0290) with sample water. Fill to the 10 line with sample.
6. Insert tube into chamber, close lid and select `SCAN BLANK`.
7. Remove tube from Spectro. Use the 0.1 g spoon (0699) to add one measure of Aminoantipyrine Reagent (7825-C). Cap and mix until powder dissolves.
8. Use the plain pipet (0352) to add 4 drops of *Ammonium Hydroxide Solution (7826). Cap and mix.
9. Use the 1 mL pipet (0354) to add 2 mL of *Potassium Ferricyanide Solution (7827). Cap and mix. Solution will almost immediately develop a reddish hue if phenols are present.
10. Insert tube into chamber, close lid and select `SCAN SAMPLE`. Record result.
11. Press **OFF** button to turn spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

PHOSPHATE–LOW RANGE

ASCORBIC ACID REDUCTION METHOD • CODE 3653-SC

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

*WARNING: Reagents marked with an * are considered hazardous substances. To view or print a Material Safety Data Sheet (MSDS) for these reagents see MSDS CD or our web site. To obtain a printed copy, contact us by e-mail, phone or fax.

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

APPLICATION: Drinking, surface, and saline waters; domestic and industrial wastes (Method based on reactions that are specific for orthophosphate).

RANGE: 0.00–3.00 ppm Orthophosphate

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

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select `PROGRAMMED TESTS`.
3. Scroll to and select `ALL TESTS` (or another sequence containing `78 Phosphate-L`) from `TESTING MENU`.
4. Scroll to and select `78 Phosphate-L` from menu.
5. Rinse a clean tube (0290) with sample water. Fill to the 10 line with sample.
6. Insert tube into chamber, close lid and select `SCAN BLANK`.
7. Remove tube from Spectro. Use 1.0 mL pipet (0354) to add 1.0 mL of *Phosphate Acid Reagent (V-6282). Cap and mix.
8. Use the 0.1 g spoon (0699) to add one measure of *Phosphate Reducing Reagent (V-6283). Cap and shake until powder dissolves. Wait 5 minutes for full color development. Solution will turn blue if phosphates are present.
9. At end of 5 minute waiting period, mix, insert tube into chamber, close lid and select `SCAN SAMPLE`. Record result.
10. Press **OFF** button to turn spectrophotometer 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
2 x 60 mL	*VM Phosphate Reagent	*4410-H
1	Pipet, 1.0 mL, plastic	0354

*WARNING: Reagents marked with an * are considered hazardous substances. To view or print a Material Safety Data Sheet (MSDS) for these reagents see MSDS CD or our web site. To obtain a printed copy, contact us by e-mail, phone or fax.

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

APPLICATION: Boiler, cooling, and industrial waters.

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

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select `PROGRAMMED TESTS`.
3. Scroll to and select `ALL TESTS` (or another sequence containing `79 Phosphate-H`) from `TESTING MENU`.
4. Scroll to and select `79 Phosphate-H` 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 Spectro. Use the 1.0 mL pipet (0354) to add 2.0 mL of *VM Phosphate Reagent (4410). Cap and mix. Wait 5 minutes for full color development.
8. After 5 minute waiting period, mix, insert tube into chamber, close lid and select `SCAN SAMPLE`. Record result.
9. Press **OFF** button to turn spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

PHOSPHORUS, TOTAL - LOW RANGE

Ascorbic Acid Reduction with Persulfate Digestion Method
Code 4024

QUANTITY	CONTENTS	CODE
25	*Total Phosphorus Acid Reagent Tubes	*4035-G
5 g	*Digestion Reagent Powder	*4036-C
2 X 30 mL	*Total Phosphorus LR Hydroxide Reagent	*4038-G
2 X 30 mL	*Phosphate Acid Reagent	*V-6282-G
5 g	Phosphate Reducing Reagent	V-6283-C
1	Spoon, 0.15 g, plastic	0727
3	Pipets, 1.0 mL, plastic	0354
1	Spoon, 0.1 g, plastic	0699
2	Funnels, plastic	0459

*WARNING: Reagents marked with an * are considered hazardous substances. To view or print a Material Safety Data Sheet (MSDS) for these reagents see MSDS CD or our web site. To obtain a printed copy, contact us by e-mail, phone or fax.

☑ Note: for greater accuracy, use laboratory grade pipets.

Equipment needed but not supplied:

1	COD Adapter	5-0087
1	COD Reactor, 12 tubes, 110V	5-0102
or 1	COD Reactor, 12 tubes, 230V	5-0102-EX

Optional Equipment:

1	Volumetric pipet, 5.0 mL	2-2174
2	Volumetric pipets, 1.0 mL	2-2170
1	Pipet Bulb	2-2164
1	Wipes	2-2069
1	Test Tube Rack	23371
1	Timer	9371-W13
1	Test Tube Holder	2-2190

Phosphorus in natural waters and wastewaters occurs almost exclusively in the form of orthophosphates, condensed phosphates (pyro-, meta- and other polyphosphates) and organically bound phosphates. Phosphates may be added in small amounts to water supplies during treatment. Larger amounts are introduced to water used for cleaning or laundering as components of commercial cleaning preparations. Phosphates are used to treat boiler water and are components of agricultural and residential fertilizers. Phosphorus is an important nutrient for aquatic plants. The amount found in natural water is generally not more than 0.1 mg/L unless the water has become polluted from wastewater sources or excessive drainage from agricultural areas.

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

RANGE: 0.00–3.50 mg/L Total Phosphorus as phosphate

METHOD: Pretreatment of the sample with heat and acid provides conditions for the hydrolysis of condensed inorganic phosphates. Heat, acid and persulfate convert the organic phosphates to orthophosphate during the digestion. Ammonium molybdate and antimony potassium tartrate react in a filtered acid medium with dilute solutions of phosphate 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.

SAMPLE HANDLING AND PRESERVATION: Rinse sample bottle with 1:1 hydrochloric acid followed by deionized water. Do not use phosphate detergents. If the sample can not be analyzed immediately, the sample should be preserved by adjusting the pH to 2 or less with concentrated sulfuric acid and refrigerated at 4°C. Warm the sample to room temperature and neutralize with 5.0 N sodium hydroxide before analyzing.

INTERFERENCES: Large amounts of turbidity may interfere. Aluminum (>200 ppm), arsenate (any level), chromium (>100 ppm), copper (>10 ppm), Iron (>100 ppm), Nickel (>300 ppm), silica (>50 ppm), silicate (>10 ppm), sulfide (>90 ppm) and zinc (>80 ppm) will interfere.

PROCEDURE

Use universal sample holder

1. Preheat COD reactor to 150 ±2°C. Follow safety precautions.
2. Remove cap from a *Total Phosphorus Acid Reagent Tube (4035). Use a 1.0 mL pipet (0354) to add 5.0 mL of sample.
3. Use the 0.15 g spoon (0727) and a funnel (0459) to add one level measure of *Digestion Reagent Powder (4036). Tap funnel to dispense powder completely. Cap tube tightly and shake until powder dissolves completely.
4. Place the tube in the COD reactor for 30 minutes.
5. At the end of the heating period, turn the reactor off. Carefully remove the tube from the reactor and allow it to cool to room temperature.
6. At the end of the cooling period, press **ON** button until spectrophotometer turns on.
7. Scroll to and select `PROGRAMMED TESTS` from menu.
8. Scroll to and select `ALL TESTS` (or another sequence containing `82 Phosphorus T LR` from `PROGRAMMED TESTS` menu.
9. Scroll to and select `82 Phosphorus T LR` from the menu.
10. Carefully remove the caps from the digested tube. Use another 1 mL pipet (0354) to add 1.0 mL of *Total Phosphorus LR Hydroxide Reagent (4038) to the tube. Cap and invert to mix.
11. Wipe the vial with a damp towel to remove fingerprints and smudges. Wipe with a dry towel.
12. Insert the tube into the chamber. Select `SCAN BLANK`. Remove the tube from the spectrophotometer.
13. Use another 1 mL pipet (0354) to add *1.0 mL of Phosphate Acid Reagent (V-6282). Cap and invert tube to mix.
14. Use the 0.1g spoon (0699) and a funnel (0459) to add one level spoon of Phosphate Reducing Reagent (V-6283). Tap funnel to dispense powder completely. Cap tube and shake until powder dissolves.
15. Wait 5 minutes.
16. Wipe the tubes with a damp towel to remove fingerprints and smudges. Wipe with a dry towel.
17. Insert the tube into the chamber. Select `SCAN SAMPLE`. Record the result as Total Phosphorus in mg/L PO_4.
18. Press **OFF** button to turn the spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

☑ NOTE: For greater accuracy, use laboratory grade pipets. To order reagent refills, order code R-4024.

PHOSPHORUS, TOTAL - HIGH RANGE

Molybdovanadate Method with Acid Persulfate Digestion
Code 4025

QUANTITY	CONTENTS	CODE
25	*Total Phosphorus Acid Reagent Tubes	*4035-G
60 mL	Deionized Water	5115PS-H
5 g	*Digestion Reagent Powder	*4036- C
2 X 30 mL	*Total Phosphorus HR Hydroxide Reagent	*4037-G
30 mL	*Total Phosphorus HR Indicator Reagent	*4039-G
1	Spoon, 0.15 g	0727
3	Pipets 1.0 mL, plastic	0354
1	Pipet, 0.5 mL	0353
1	Funnel, plastic	0459

*WARNING: Reagents marked with an * are considered hazardous substances. To view or print a Material Safety Data Sheet (MSDS) for these reagents see MSDS CD or our web site. To obtain a printed copy, contact us by e-mail, phone or fax.

☑ Note: for greater accuracy, use laboratory grade pipets.

Equipment needed but not supplied:

1	COD Reactor, 8 vial, 110V	5-0069
Or 1	COD Reactor, 8 vial, 220V	5-0070
Or 1	COD Reactor, 25 vial, 115V/230V	5-0094

Optional Equipment

1	Volumetric pipet, 2.0 mL	2-2168
2	Volumetric pipet, 5.0 mL	2-2174
1	Volumetric pipet, 0.5 mL	30503
1	Pipet Bulb	2-2164
1	Wipes	2-2069
1	Test Tube Rack	23371
1	Timer	9371-W13
1	Test Tube Holder	2-2190

Phosphorus in natural waters and wastewaters occurs almost exclusively in the form of orthophosphates, condensed phosphates (pyro-, meta- and other polyphosphates) and organically bound phosphates. Phosphates may be added in small amounts to water supplies during treatment. Larger amounts are introduced to water used for cleaning or laundering as components of commercial cleaning preparations. Phosphates are used to treat boiler water and are components of agricultural and residential fertilizers. Phosphorus is an important nutrient for aquatic plants. The amount found in natural water is

generally not more than 0.1 mg/L unless the water has become polluted from wastewater sources or excessive drainage from agricultural areas.

APPLICATION: Boiler, cooling, and industrial water.

RANGE: 0.0–100.0 mg/L Total Phosphorus as phosphate

METHOD: Pretreatment of the sample with heat and acid provides conditions for the hydrolysis of condensed inorganic phosphates. Heat, acid and persulfate convert the organic phosphates to orthophosphate during the digestion. Orthophosphate reacts in acid conditions with ammonium vanadomolybdate to form vanadomolybdophosphoric acid. The resulting yellow color is proportional to the concentration of orthophosphate.

SAMPLE HANDLING AND PRESERVATION: Rinse sample bottle with 1:1 hydrochloric acid followed by deionized water. Do not use phosphate detergents. If the sample can not be analyzed immediately, the sample should be preserved by adjusting the pH to 2 or less with concentrated sulfuric acid and refrigerated at 4°C. Warm the sample to room temperature and neutralize with 5.0 N sodium hydroxide before analyzing.

INTERFERENCES: Large amounts of turbidity may interfere. Silica and arsenate interfere only if the sample is heated. Arsenite, fluoride, thorium, bismuth, molybdate, thiosulfate, and thiocyanate cause negative interference. Ferrous iron concentrations above 100 ppm will interfere.

☑ NOTE: For greater accuracy, use laboratory grade pipets. To order reagent refills, order code R-4025.

PROCEDURE

Use universal sample holder

1. Preheat COD reactor to 150 ±2°C. Follow safety precautions.
2. Remove cap from a *Total Phosphorus Acid Reagent Tube (4035). Use a 1.0 mL pipet (0354) to add 5.0 mL of Deionized Water (5115PS). This is the blank.
3. Remove cap from a *Total Phosphorus Acid Reagent Tube (4035). Use another 1.0 mL pipet (0354) to add 5.0 mL of sample water. This is the sample.
4. Use the 0.15 g spoon (0727) and a funnel (0459) to add one level measure of *Digestion Reagent Powder (4036) to each tube. Tap funnel to dispense powder completely. Cap tube tightly and shake until powder completely dissolves.
5. Place the tubes in the COD reactor for 30 minutes.
6. At the end of the heating period, turn the reactor off. Carefully remove the tubes from the reactor block and allow them to cool to room temperature.
7. Carefully remove the caps from the digested tubes. Use another 1 mL pipet (0354) to add 2.0 mL of *Total Phosphorus HR Hydroxide Reagent (4037) to each tube. Cap and invert to mix.
8. Use the 0.5 mL pipet (0353) to add 0.5 mL *Total Phosphorus HR Indicator Reagent (4039) to each tube. Cap and invert to mix. Wait 7 minutes.
9. During the waiting period, press **ON** button until spectrophotometer turns on.
10. Scroll to and select `PROGRAMMED TESTS` from menu.
11. Scroll to and select `ALL TESTS` (or another sequence containing `83 Phosphorus T HR`) from `PROGRAMMED TESTS` menu.
12. Scroll to and select `83 Phosphorus T HR` from the menu.
13. Wipe the vials with a damp towel to remove fingerprints and smudges. Wipe with a dry towel.
14. Insert the blank tube into the chamber. Select `SCAN BLANK`. Remove the blank tube from the spectrophotemeter.
15. Insert the sample tube into the chamber. Select `SCAN SAMPLE`. Record the result as Total Phosphorus in mg/L PO_4.
16. Press **OFF** button to turn the spectrophotometer 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 an * are considered hazardous substances. To view or print a Material Safety Data Sheet (MSDS) for these reagents see MSDS CD or our web site. To obtain a printed copy, contact us by e-mail, phone or fax.

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 waters.

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 15).

PROCEDURE

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select `PROGRAMMED TESTS`.
3. Scroll to and select `ALL TESTS` (or another sequence containing `81 Potassium`) from `TESTING MENU`.
4. Scroll to and select `81 Potassium` from menu.
5. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
6. Insert tube into chamber, close lid and select `SCAN BLANK`.
7. Remove tube from Spectro. Add 4 drops of *Sodium Hydroxide, 1.0N (4004WT). Cap and mix.
8. Use the 0.05 g spoon (0696) to add one measure of *Tetraphenylboron Powder (6364). Cap and shake vigorously until all of the powder has dissolved. Wait 5 minutes.
9. At end of 5 minute waiting period, mix tube again to suspend any settled precipitate. Immediately insert tube into chamber, close lid and select `SCAN SAMPLE`. Record result.
10. Press **OFF** button to turn spectrophotometer 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±4°C.

SILICA–LOW RANGE

HETEROPOLY BLUE METHOD • CODE 3664-SC

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

*WARNING: Reagents marked with an * are considered hazardous substances. To view or print a Material Safety Data Sheet (MSDS) for these reagents see MSDS CD or our web site. To obtain a printed copy, contact us by e-mail, phone or fax.

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

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

APPLICATION:	Drinking, surface, and saline waters; domestic and industrial wastes.
RANGE:	0.00–2.50 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

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select PROGRAMMED TESTS.
3. Scroll to and select ALL TESTS (or another sequence containing 85 Silica Lo) from TESTING MENU.
4. Scroll to and select 85 Silica Lo from menu.
5. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
6. Insert tube into chamber, close lid and select SCAN BLANK. (See Note)
7. Remove tube from Spectro. Add 6 drops *Silica Reagent #1 (V-4466). Cap and invert to mix.
8. Add 12 drops of *Silica Reagent #2 (V-4467). Cap and mix. Wait 5 minutes.
9. Add 8 drops of *Silica Reagent #3 (V-4468). Cap and mix. Wait 2 minutes.
10. Use the 0.1 g spoon (0699) to add one measure of *Silica Reagent #4 (V-6284). Cap and mix gently until powder has dissolved. Wait 5 minutes for full color development.
11. At end of 5 minute waiting period, mix, insert tube into chamber, close lid and select SCAN SAMPLE. Record result.
12. Press **OFF** button to turn spectrophotometer 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 an * are considered hazardous substances. To view or print a Material Safety Data Sheet (MSDS) for these reagents see MSDS CD or our web site. To obtain a printed copy, contact us by e-mail, phone or fax.

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

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

APPLICATION: Boiler and cooling waters; domestic and industrial wastes.

RANGE: 0–50 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

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select `PROGRAMMED TESTS`.
3. Scroll to and select `ALL TESTS` (or another sequence containing `86 Silica Hi`) from `TESTING MENU`.
4. Scroll to and select `86 Silica Hi` 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 Spectro. Add 6 drops *Silica Reagent #1 (V-4466). Cap and invert to mix.
8. Add 12 drops of *Silica Reagent #2 (V-4467). Cap and mix. Wait 5 minutes.
9. At end of 5 minute waiting period, add 8 drops of *Silica Reagent #3 (V-4468). Cap and mix.
10. Insert tube into chamber, close lid and select `SCAN SAMPLE`. Record result.
11. Press **OFF** button to turn spectrophotometer 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

BARIUM CHLORIDE METHOD • CODE 3665-SC

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

*WARNING: Reagents marked with an * are considered hazardous substances. To view or print a Material Safety Data Sheet (MSDS) for these reagents see MSDS CD or our web site. To obtain a printed copy, contact us by e-mail, phone or fax.

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

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

RANGE: 6–100 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 15).

PROCEDURE

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select PROGRAMMED TESTS.
3. Scroll to and select ALL TESTS (or another sequence containing 89 SULFATE-HR) from TESTING MENU.
4. Scroll to and select 89 SULFATE-HR from menu.
5. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
6. Insert tube into chamber, close lid and select SCAN BLANK.
7. Remove tube from Spectro. Use the 0.1 g spoon (0699) to add one measure of *Sulfate Reagent (V-6277). Cap and shake until powder dissolves. A white precipitate will develop if sulfates are present. Wait 5 minutes.
8. Mix tube again. Insert tube into chamber, close lid and select SCAN SAMPLE. Record result.
9. Press **OFF** button to turn spectrophotometer 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±4°C.

SULFIDE

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 an * are considered hazardous substances. To view or print a Material Safety Data Sheet (MSDS) for these reagents see MSDS CD or our web site. To obtain a printed copy, contact us by e-mail, phone or fax.

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

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

RANGE: 0.00–1.00 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

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select `PROGRAMMED TESTS`.
3. Scroll to and select `ALL TESTS` (or another sequence containing `90 Sulfide-LR`) from `TESTING MENU`.
4. Scroll to and select `90 Sulfide-LR` from menu.
5. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
6. Insert tube into chamber, close lid and select `SCAN BLANK`.
7. Remove tube from Spectro. Use the 1.0 mL pipet (0354) to add 1.0 mL of *Sulfide Reagent A (V-4458). Cap and mix.
8. Add 6 drops of Sulfide Reagent B (V-4459). Cap and mix. Wait 1 minute. Solution will turn blue if sulfides are present.
9. Use the 1.0 mL pipet (0354) to add 2.0 mL of Sulfide Reagent C (4460). Cap and mix. Color development is immediate and stable.
10. Insert tube into chamber, close lid and select `SCAN SAMPLE`. Record result.
11. Press **OFF** button to turn spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

SURFACTANTS

ION PAIR EXTRACTION–BROMPHENOL BLUE INDICATOR CODE 4876

QUANTITY	CONTENTS	CODE
50 g	pH Adjustment Powder	4509- H
10 g	Sodium Chloride Reagent	4877-D
2 X 60 mL	*DS Indicator Reagent	*4508-H
1	Spoon, 0.5 g, plastic	0698
1	Spoon, 0.1 g, plastic	0699
1	Pipet, 1.0 mL, plastic	0354

*WARNING: Reagents marked with an * are considered hazardous substances. To view or print a Material Safety Data Sheet (MSDS) for these reagents see MSDS CD or our web site. To obtain a printed copy, contact us by e-mail, phone or fax.

Aqueous waste from households and industrial laundering operations is the main source of surfactants in waters. Surfactants are found in low concentrations in natural water except in areas of an outfall or other point source.

APPLICATION: Surface water, wastewater.

RANGE: 0.5–8.0 ppm as Linear Alkyl Sulfonates (LAS).

METHOD: The presence of LAS in the water sample causes the transfer of bromphenol blue dye from the organic reagent layer to the aqueous layer. The amount of color in the aqueous layer is proportional to the concentration of the LAS in the sample. LAS are Methylene Blue Active Substances (MBAS). This calibration is based on sodium lauryl sulfate (dodecyl sodium sulfate). Some linear alkyl sulfonates may have a slightly different response. Prepare standards of a known concentration and follow the test procedure below to determine a conversion factor.

SAMPLE HANDLING & PRESERVATION: Analyze samples as soon as possible. May be stored at 4°C for 24 hours. Warm to room temperature before testing.

INTERFERENCES: Cationic and non-ionic surfactants.

PROCEDURE

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select `PROGRAMMED TESTS`.
3. Scroll to and select `ALL TESTS` (or another sequence containing `94 Surfactants`) from `TESTING MENU`.
4. Scroll to and select `94 Surfactants` from menu.
5. Rinse a tube (0290) with sample water. Fill to 10 mL line with sample.
6. Insert the tube into chamber, close lid and select `SCAN BLANK`.
7. Remove the tube from Spectro.
8. Use the 0.5 g spoon (0698) to add 0.5 g pH Adjustment Powder (4509). Cap and mix until powder dissolves.
9. Use the 0.1 g spoon (0699) to add two measures of Sodium Chloride Reagent (4877). Cap and mix until powder disintegrates.
10. Use the 1.0 pipet (0354) to add 2.0 mL of *DS Indicator (4508).
11. Cap and shake for 1 minute.
12. Wait 5 minutes. DO NOT MIX.
13. Insert tube into chamber, close lid and select `SCAN SAMPLE`. Record result in ppm LAS.
14. Press **OFF** button to turn the spectrophotometer 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.

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 an * are considered hazardous substances. To view or print a Material Safety Data Sheet (MSDS) for these reagents see MSDS CD or our web site. To obtain a printed copy, contact us by e-mail, phone or fax.

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

APPLICATION: Industrial wastewaters; boiler and cooling waters; natural waters.

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

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select PROGRAMMED TESTS.
3. Scroll to and select ALL TESTS (or another sequence containing 96 TANNIN) from TESTING MENU.
4. Scroll to and select 96 TANNIN from menu.
5. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
6. Insert tube into chamber, close lid and select SCAN BLANK.
7. Remove tube from Spectro. Use the plain pipet (0352) to add 4 drops of *Tannin Reagent #1 (7833). Cap and mix.
8. Use the 1.0 mL pipet (0354) to add 2.0 mL of *Tannin Reagent #2 (7834). Cap and mix. Wait 30 minutes for full color development.
9. At end of 30 minute waiting period, mix, insert tube into chamber, close lid and select SCAN SAMPLE. Record result.
10. Press **OFF** button to turn spectrophotometer 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±2°C.

TURBIDITY

ABSORPTION METHOD • NO REAGENTS REQUIRED

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

APPLICATION:	Surface and industrial waters for non-compliance monitoring. (For compliance monitoring at low turbidity levels, use a commercial .)
RANGE:	0–400 FTUs
METHOD:	Absorptimetric
SAMPLE HANDLING & PRESERVATION:	Measure sample as soon as possible after collection.
INTERFERENCES:	Check for stray light interference

PROCEDURE

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select `PROGRAMMED TESTS`.
3. Scroll to and select `ALL TESTS` (or another sequence containing `98 Turbidity`) from `TESTING MENU`.
4. Scroll to and select `98 Turbidity` from menu.
5. Rinse a clean tube (0290) with deionized water (turbidity free). Fill to the 10 mL line with deionized water.
6. Insert tube into chamber, close lid and select `SCAN BLANK`.
7. Rinse a second clean tube (0290) with sample water. Fill to the 10 mL line with sample. Cap tube. Wipe off excess water and fingerprints. Shake to resuspend particulate matter. Remove all bubbles before measurement.
8. Insert tube into chamber, close lid and select `SCAN SAMPLE`. Record result. Turbidity measurements should be taken as soon as possible after sample has been collected.
9. Press **OFF** button to turn spectrophotometer 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±4°C.

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

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 an * are considered hazardous substances. To view or print a Material Safety Data Sheet (MSDS) for these reagents see MSDS CD or our web site. To obtain a printed copy, contact us by e-mail, phone or fax.

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

APPLICATION: Drinking and surface waters; domestic and industrial wastewaters.

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

Use universal sample holder.

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 spectrophotometer turns on.
2. Scroll to and select `PROGRAMMED TESTS`.
3. Scroll to and select `ALL TESTS` (or another sequence containing `99 Zinc-LR`) from `TESTING MENU`.
4. Scroll to and select `99 Zinc-LR` from menu.
5. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
6. Insert tube into chamber, close lid and select `SCAN BLANK`. (See Note)
7. Remove tube from Spectro. Use 0.1 g spoon (0699) to add one measure of Sodium Ascorbate Powder (6316). Use 0.5 g spoon (0698) to add one measure of *Zinc Buffer Powder (6315). Cap and shake vigorously for 1 minute. Some undissolved buffer may remain in the bottom of the tube.
8. Add 3 drops of *Sodium Cyanide, 10% (6565). Cap and mix.
9. Use the 1 mL pipet assembly to add 1 mL of "Dilute Zinc Indicator Solution". Cap and mix.
10. Use a second plain pipet (0352) to add 4 drops of *Formaldehyde Solution, 37% (5128). Cap and mix by inverting 15 times.
11. Insert tube into chamber, close lid and select `SCAN SAMPLE`. Record result.
12. Press **OFF** button to turn spectrophotometer 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.

SMART Spectro

Spectrophotometer

APPENDIX

LaMotte

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 Ionized Ammonia-Nitrogen (NH_4^+–N), subtract the unionized ammonia-nitrogen determined in Step 2 from the total ammonia-nitrogen.

	10□C		15□C		20□C		25□C	
pH	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

[1]Freshwater data from Trussel (1972).

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

FOR EXAMPLE:

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

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

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