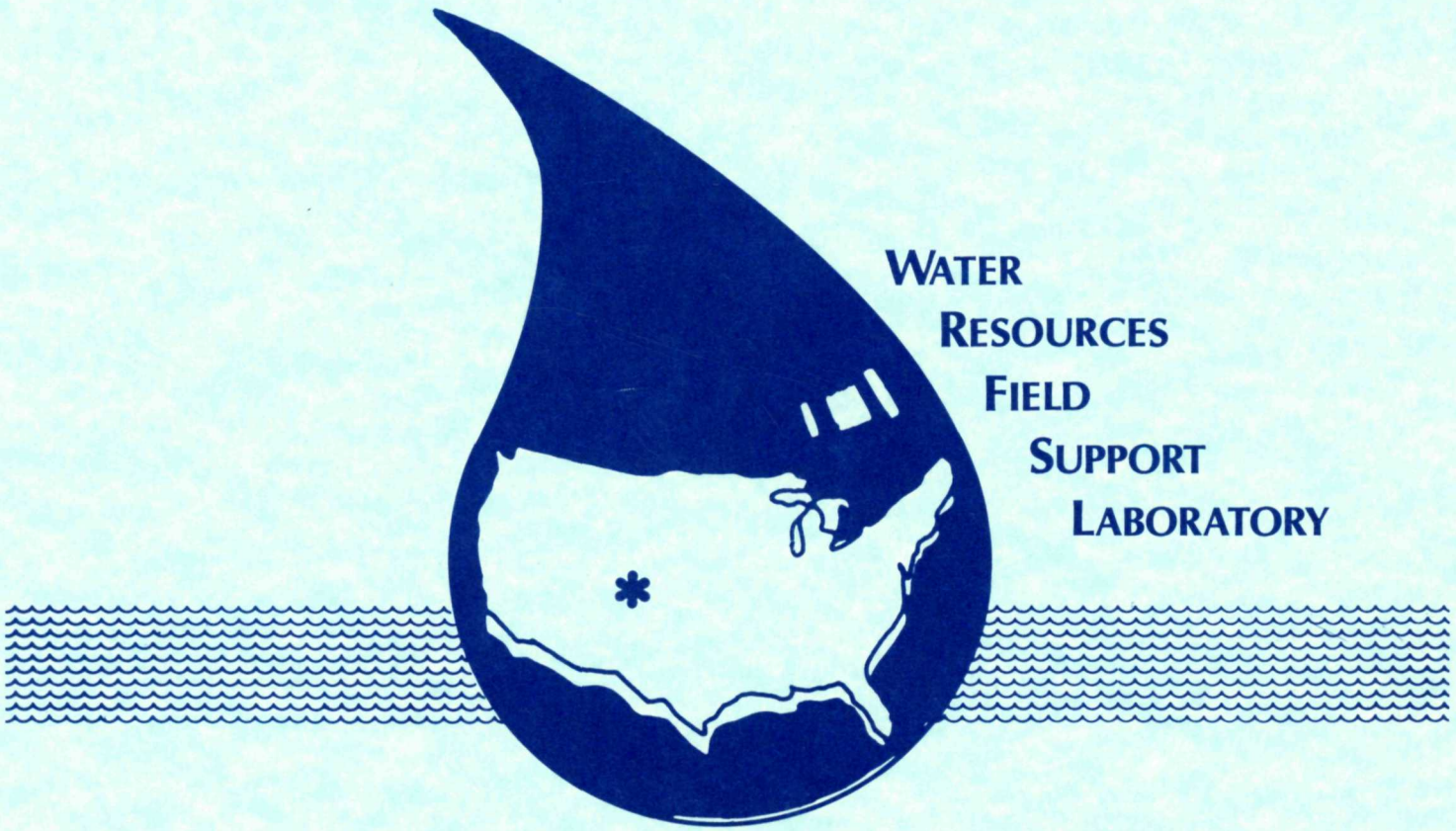
PORTABLE KITS FOR WATER CHEMISTRY RECONNAISSANCE IN THE FIELD



WRFSL Report No. 84-2

WATER RESOURCES FIELD SUPPORT LABORATORY
NATIONAL PARK SERVICE
COLORADO STATE UNIVERSITY
FORT COLLINS, COLORADO 80523

The Water Resources Report Series of the National Park Service, Water Resources Field Support Laboratory, Colorado State University, Fort Collins, Colorado, provides the means for distributing to National Park Service regional and field staff the results of studies and other scientific information useful for the management, preservation and protection of the water and related riparian resources of the National Park System.

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PORTABLE KITS FOR WATER CHEMISTRY RECONNAISSANCE IN THE FIELD

WRFSL Report No. 84-2

Samuel H. Kunkle
Thomas E. Ricketts

September, 1984

Water Resources Field Support Laboratory
National Park Service
Colorado State University
Fort Collins, Colorado 80523

QUALIFICATION STATEMENT

This paper has been prepared from a review of specification sheets, catalog descriptions and brochures on water chemistry kits from the manufacturers of such equipment known to us at this time. No effort has been made to investigate non-U.S. manufacturers, nor have we listed distributors of equipment of this type (although some of the companies have international distributors). No attempt has been made to rate the quality of the various brands or to confirm if individual kits work as claimed. Mention of brands does not represent endorsement by the National Park Service, Water Resources Field Support Laboratory or any other organization with which our laboratory affiliates. Likewise, omission of a brand is purely an oversight.

ACKNOWLEDGMENTS

The information is this paper was compiled with help from Greg Lynch, Randy Nickerson, and Elizabeth Caldwell, Technical Assistants, and Juliette Wilson, Editor. Special thanks is due Dana Heimbecker, Ph.D. candidate in the Department of Chemistry, Colorado State University, for his technical expertise and review comments. Photographs for the figures shown were generously provided by the various manufacturers, as noted in each figure.

SUMMARY

This paper highlights information on ten different brands of portable test kits used for measuring water chemistry. The kits are useful tools for detecting pollution and for routine water quality reconnaissance in streams, lakes and other field sites.

Ten brands of kits and various models offered by each brand are described briefly in terms of (a) the types of kits available, (b) the chemical constituents that may be tested by each brand, (c) the initial costs of acquiring various kits or models and (d) the availability of combination kits or portable laboratories.

The principal tests available with each brand are summarized under the following categories: alkaline earths, metals, phosphorus or nitrogen nutrients, toxic substances, organic compounds, anions, special tests such as turbidity, and other tests.

Most of the portable kits are similar in that they contain some type of color comparison device or battery-operated colorimeter for measuring the presence of a color, where the color is indicative of the concentration of a particular chemical constituent. The colors are developed via the addition of standard reagents included with the kits. Many kits also use a titration technique, where a solution is dripped into a water sample until reaching a color-detected end point. The dripping solution is measured with a calibrated syringe, burette, or other device such as one company's digital dripper.

Generally, kits are available within three levels of sophistication: (a) the simple, hand-held variety of color or titration kits for individual tests or tests measuring only a few parameters,

usually selling for $10-$40; (b) small, battery-operated colorimeters selling for $200-$700 for which reagents may be purchased for several tests; and (c) the larger, suitcase-type portable laboratories for multiple tests, selling for $1000 or more, which typically include a built-in colorimeter, one or more titration devices and other attachments. These larger multiple-purpose outfits also may include optical or electrical devices such as turbidimeters or conductance meters.

The ten U.S. companies summarized in the paper are: Bausch and Lomb, CHEMetrics, Ecologic, EM Science, Hach, Hellige, Kahl Scientific, LaMotte, Soiltest and Taylor.

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INTRODUCTION

Field kits for testing water chemistry are handy tools because of their relatively small size, modest cost and suitability for outdoor use. These simple kits are used to:

- carry out reconnaissance work for a preliminary on-site analysis of pollution in waters;
- help locate pollution sources in the field;
- take a series of inexpensive measurements along a stream or during a storm period to ascertain variations in water chemistry caused by hydrologic influences;
- help teach technicians or scientists more about water quality processes, such as mixing and dilution, through field demonstration; and
- supplement more elaborate sampling programs where laboratory analyses are used.

As with any tools, the field kits have limitations, typically being neither as accurate nor as sensitive for low detection work as larger laboratory equipment. The kits are not a substitute for laboratory analyses, but they are valuable tools for field reconnaissance work when used within their capabilities.

This paper highlights the chemical kits available from several companies and indicates price ranges for the various tests, which extend from $10 to $20 for the small, one-test kits up to over $1000 for the multiple-parameter portable laboratories.

We assume that readers interested in more details will write to the companies listed, so our presentation is kept brief.

The kits are all similar and function in one of two ways:

1. For many water quality parameters, a fixed measure of reagent is added to a water sample and a color develops in the solution. The color's intensity is measured using a disc of colored lenses, a battery colorimeter, a series of colored tubes or other color comparator device supplied, and can then be interpreted as "concentration" of the substance.
2. For other tests a given reagent is titrated into a water sample until an end point (color change) occurs. Titration is done using an eye dropper, syringe, digital reading burette or other device supplied. Hardness, alkalinity, acidity, and some other variables are quantified in this way.

A few of the more elaborate kits, actually portable laboratories, include built-in optical or electronic meters for turbidity, pH or electrical conductivity.

WHAT TO LOOK FOR IN A KIT

When looking over the various kits, keep these points in mind:

1. How are the reagents packaged? This varies from handy tablets or break-open plastic "pillows" to larger jars of powder. Not only are the tablets and pillows more convenient for outdoor use or for testing done only occasionally, but they are not subject to waste via contamination or spillage.
2. What is the price per individual test? How many tests does a kit enable you to do? For example, some tests are over $1.00 each and others less than $0.20 per test.

3. Especially important is the availability of refills and the way they are sold. For example, one major company in the group does not sell any reagent refills, so that each time reagents are used up another entire kit must be purchased, making the tests more expensive. Also, the reagent refill service can take from one week to several months.
4. Question the value of any extra built-in meters, such as conductivity, for your work. The built-in meters may not be as good a buy for your money as a separate, high-quality meter from a major electronics firm such as Orion, Corning, Beckman, Yew, etc.
5. Do you really need one of the larger multiple-parameter kits? If many of the tests will in fact never be used, it would be better to purchase several of the individual kits instead and save both bulk and money.
6. What range of concentrations do you need to measure? Look at the concentration range covered by a kit and the degree of accuracy it allows. The kits are usually designed to read only within a given range of concentrations. The detection limits on many of the kits are relatively high so that such kits are not appropriate for analyzing pristine waters.

The kits and equipment shown in the figures are examples of a few of the many configurations used by the companies listed in this report. Many of the kit companies also are willing to tailor a test kit to a specific need (size, kinds of tests, etc.). The following pages should provide a start in answering basic questions relating to the purchase and use of these portable test kits.

Figure 1. Indicator paper test kit for measuring pH. Courtesy of EM Science.

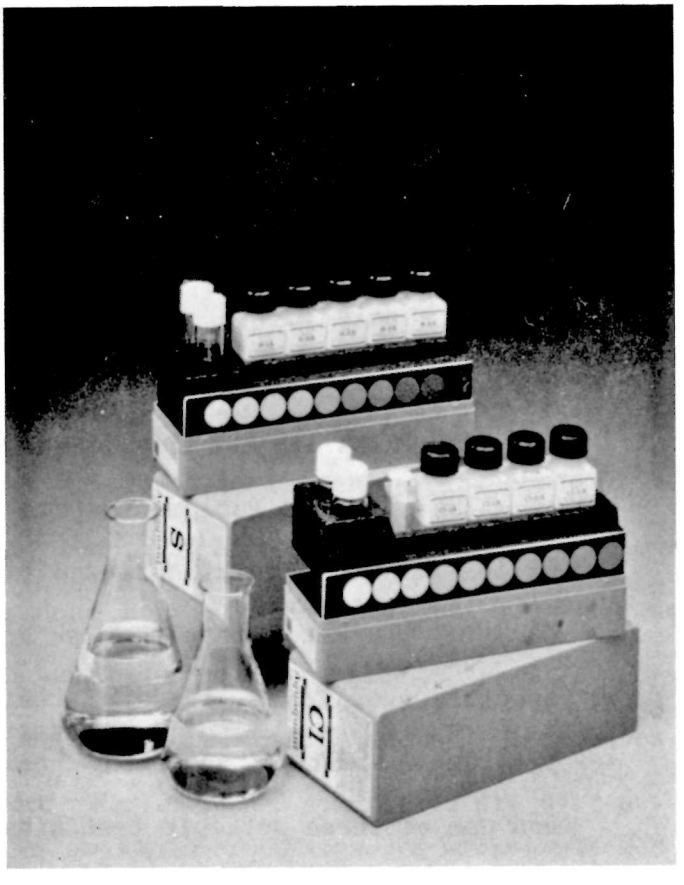

Figure 2. Test kit using color chart comparator and reagents. Courtesy of EM Science.

Figure 3. Test kit using glass tubes for comparing solution colors. Courtesy of CHEMetrics, Inc.

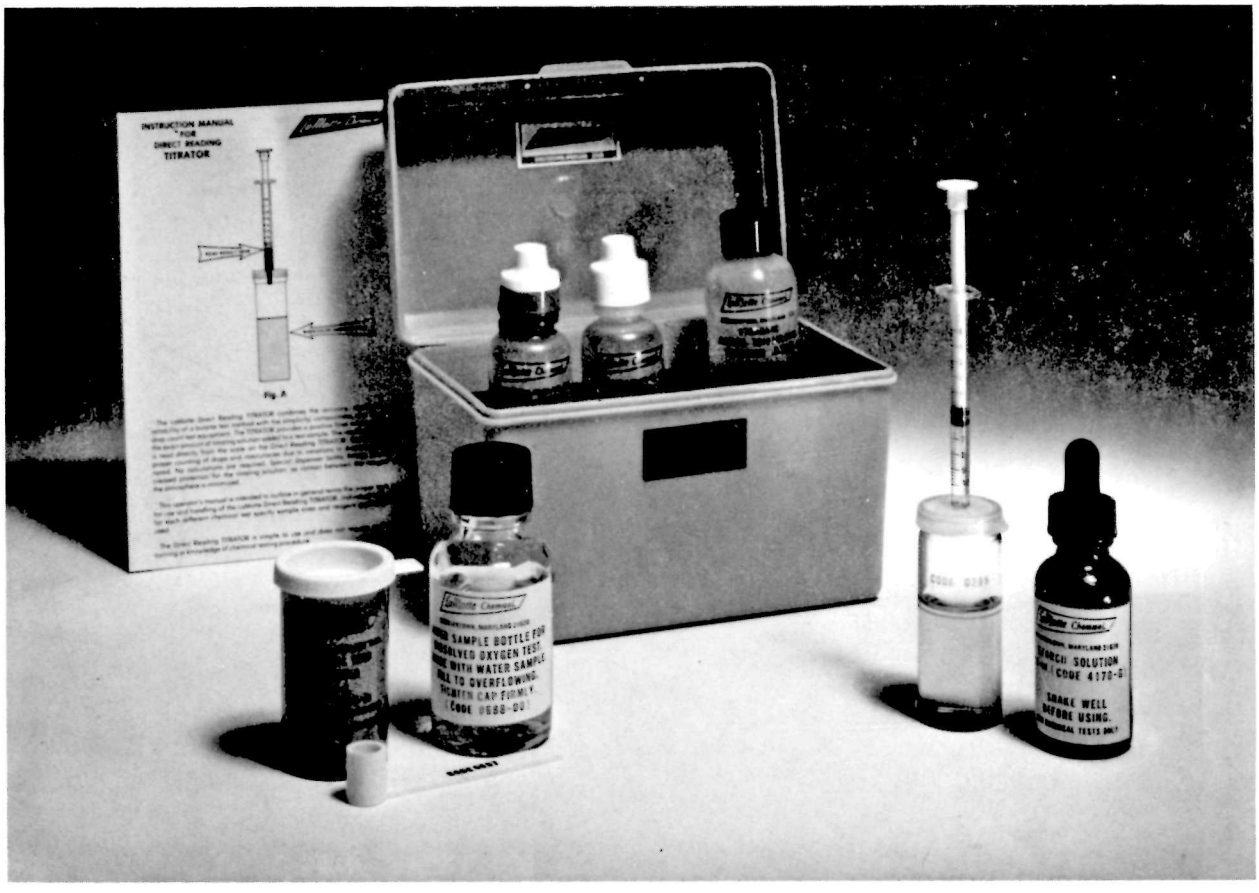

Figure 4. Test kit with a direct reading, dropper-type titrator. Courtesy of LaMotte Chemical.

Figure 5. Test kit using color wheel devices for comparing solutions. Also shown are dropper-type titrators and boxes of powder reagents in snip-open "pillows." Courtesy of Hach Co.

Figure 6. Hand-held colorimeter used for precise color comparisons. Courtesy of Hach Co.

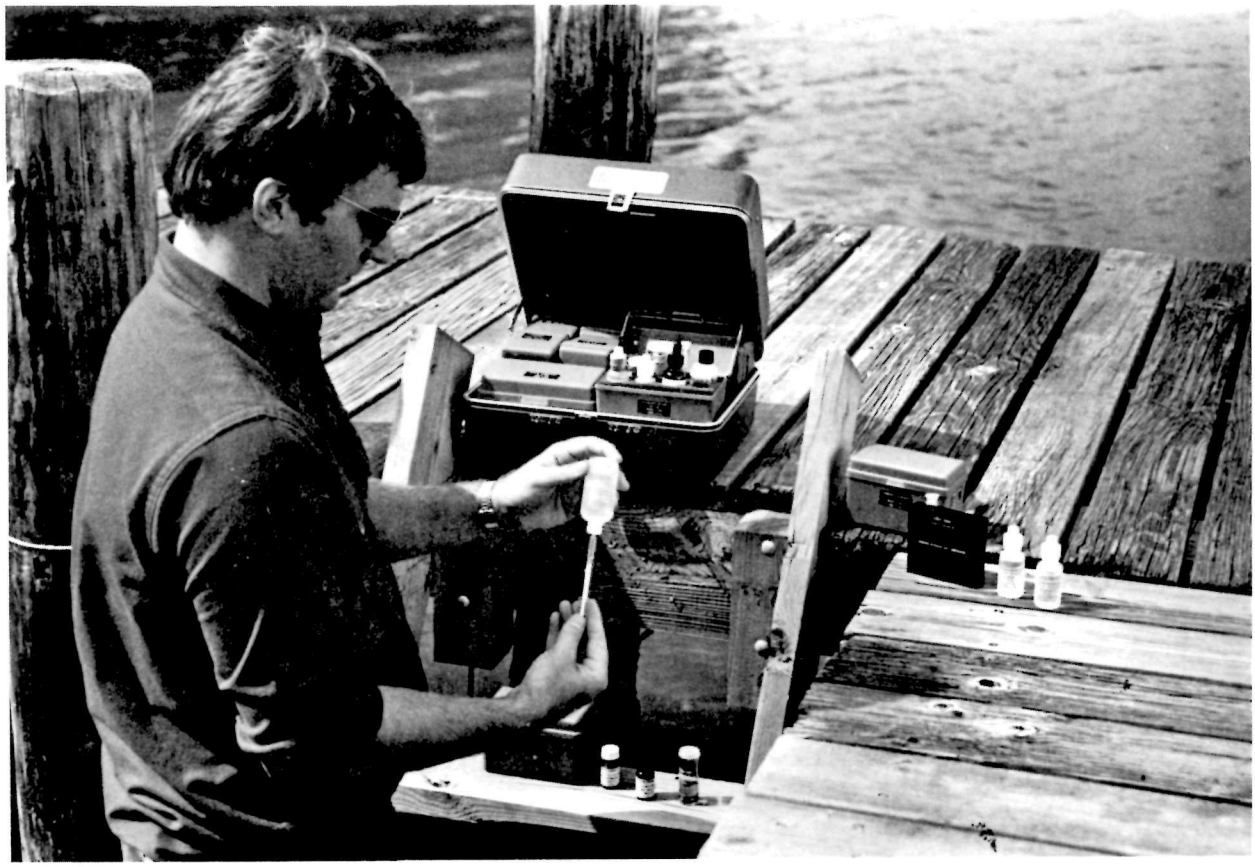

Figure 7. Multiple-parameter test kit for water pollution tests in the field. Courtesy of LaMotte Chemical.

Figure 8. Portable laboratory with spectrophotometer (in the center), digital titrator with syringes of liquid reagents (foreground) and boxes of snip-open powder reagents. Courtesy of Hach Co.

THE BAUSCH AND LOMB KITS

Bausch and Lomb
Analytic Systems Division
Dept. 7606
820 Linden Avenue
Rochester, New York 14625
(716) 338-8317

Types of Kits Available

Portable spectrophotometer

Principal Tests Available

Alkaline earths: alkalinity, total hardness

Metals: chromium, copper, iron, manganese, zinc

Nitrogen/Phosphorus: ammonia, hydrazine, nitrate, nitrite, ortho-/total phosphate

Special tests: carbon dioxide, dissolved oxygen, turbidity

Toxics: cyanide

Organics: none listed in catalog

Anions: chloride, sulfate, sulfide

Other: chlorine (free/total), silica

Kit Prices

The compact spectrophotometer, which is necessary for most of the tests listed, is approximately $700; it comes with cuvettes, scale overlays, battery charger, and carrying case.

The various SpectroKit® reagents range from $28 (carbon dioxide test) to $81 (manganese test). To check field results, standards are available for some of the tests; they range from $18 to $30.

The SpectroKits® are designed to perform 150 tests of the specified parameter; thus, individual tests cost from about $0.18 to $0.54 once the spectrophotometer is purchased. These kits can be used on other spectrophotometers as well.

THE CHEMETRICS KITS

CHEMetrics, Incorporated
Route 28
Calverton, Virginia 22016
(703) 788-9026

Types of Kits Available

Glass tubes for comparing solution colors

Dropper-type titrator

Kits for use with colorimeters or spectrophotometers

Principal Tests Available

Alkaline earths: calcium, hardness (soft and hard ranges)

Metals: copper, iron, manganese

Nitrogen/Phosphorus: ammonia, hydrazine, nitrite, orthophosphate

Special tests: carbon dioxide, low and high range dissolved oxygen, pH

Toxics: none listed in catalog

Organics: amines, phenols (dual range, 0 to 12 ppm)

Anions: chloride, fluoride, sulfite, thiosulfate

Other: chlorine (free/total), hydrogen peroxide, hydrogen sulfide

Kit Prices

The glass tube color comparator kits range from $17.50 (dissolved oxygen, high range) to $39.50 (ammonia). Refill packs for the ammonia kit are available for $17.

The various kits for use with a colorimeter or spectrophotometer are available at prices ranging from $17.50 (pH, full range) to $42.50 (iron). Iron has refill packs available for $17 (low range) and $20 (high range). Each kit provides enough reagent to complete 30 tests of the specific parameter. CHEMetrics manufactures only the kits; they do not make or supply the meters.

The dropper titrator test kits cost $18, and most come in various ppm ranges. Approximately 30 tests can be performed on each parameter; therefore, individual tests cost about $1.65 each.

THE ECOLOGIC KITS

Ecologic Instrument
132 Wilbur Place
Bohemia, L.I., New York 11716
(516) 567-9000

Types of Kits Available

Glass tubes for comparing solution colors

Dropper-type titrator

Principal Tests Available

Alkaline earths: alkalinity, hardness

Metals: copper, iron, manganese, zinc

Nitrogen/Phosphorus: ammonia, hydrazine, nitrate, nitrite, organo-phosphonate, ortho-/total phosphate

Special tests: acidity, carbon dioxide, color, dissolved oxygen, pH, salinity, turbidity

Toxics: cyanide

Organics: EDTA/NTA, phenol

Anions: chloride, chromate, fluoride, molybdate, sulfate, sulfite

Other: bromine, chlorine, hydrogen sulfide, iodine, silica

Kit Prices

The glass tube color comparator kits range from $35 (molybdate) to $80 (total phosphate test).

Titration kits range from $20 (carbon dioxide test) to $75 (EDTA/NTA test).

Each test kit comes complete with all necessary test reagents, glassware, comparator, instructions, and case; most kits contain sufficient reagent for 100 analyses. Individual analyses, once the complete kit is purchased, cost about $0.20 - $0.80.

Portable Laboratories

Ecologic has several portable laboratories available for tests of sewage, industrial, and natural waters. These outfits combine several of the individual kit tests into one handy case; many include portable spectrophotometers. Prices range from $1050 (8 to 12 tests with photometer) to $1250 (18 to 27 tests with photometer). The laboratories can be selected to include any combination of tests.

THE EM SCIENCE KITS*

EM Science
480 Democrat Road
Gibbstown, New Jersey 08027
(609) 423-6300
(800) 222-0342

Types of Kits Available

Color charts for comparing solutions

Indicator paper

Principal Tests Available

Alkaline earths: calcium, hardness

Metals: aluminum, cobalt, copper, iron, manganese, nickel, potassium, zinc

Nitrogen/Phosphorus: ammonium (ammonia), hydrazine, nitrate, nitrite, phosphate

Special tests: color, pH

Toxics: cyanide

Organics: formaldehyde

Anions: chloride, chromate, sulfate, sulfite

Other: ascorbic acid, hydrogen peroxide, hydrogen sulfide, silicon

Kit Prices

Most color chart comparator kits cost $69, but the number of tests per kit ranges from 69 (low-range ammonium) to 500 (chloride). Therefore, depending on the parameter measured, individual tests cost from $0.14 to $1.15.

The indicator paper test kits range from $16 (aluminum) to $27 (formaldehyde); individual tests cost $0.16 to $0.54, since 50 to 100 tests can be performed per kit. The test kits for pH start at $35 (any range); a pocket-sized IndicatorpHial, with three rolls of indicator paper covering three different ranges, costs $74.

*Sold under the E. Merck brand in Europe

THE HACH COMPANY KITS

Hach Company
P.O. Box 389
Loveland, Colorado 80539
(303) 669-3050

Types of Kits Available

Color cube and color wheel devices for comparing solutions
Dropper-type titrator
Colorimeter

Principal Tests Available

Alkaline earths: alkalinity, calcium, hardness, magnesium

Metals: chromium, copper, iron, manganese, potassium, zinc

Nitrogen/Phosphorus: ammonia, hydrazine, nitrate, nitrite, ortho-/total phosphate, phosphonate

Special tests: acidity, chemical oxygen demand (COD), color, dissolved oxygen, pH

Toxics: cyanide, cyanuric acid

Organics: detergents, EDTA, formaldehyde, lignin, tannin, triazole

Anions: chloride, fluoride, molybdate, sulfate, sulfite

Other: bromine, carbon dioxide, chlorine (total/free), hydrogen sulfide, iodine, ozone, silica

Kit Prices

Color cube comparator kits range from $11 to $17 for a single parameter test. Color wheel kits range from $31 (total/free chlorine) to $225 (6 tests).

Digital titrators range from $110 (acidity) to $140 (dissolved oxygen). Drop count titrators range from $8 (hardness) to $60 (chloride, high level). Replacement cartridges for digital titrators are available for $10.

Colorimetric test kits range from $175 to $395 and include the colorimeter. Most kits provide for 100 analyses.

Portable Laboratories

Complete water analysis laboratories with spectrophotometer range from $1250 to $1675 and analyze for 32 parameters. The most elaborate model comes with a built-in conductivity and portable pH meter.

THE HELLIGE KITS

Hellige, Inc.
877 Stewart Avenue
Garden City, New York 11530
(516) 222-0300

Types of Kits Available

Color wheel device for comparing solutions

Portable spectrophotometer

Principal Tests Available

Alkaline earths: alkalinity, calcium, hardness, magnesium, potassium

Metals: aluminum, barium, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, silver, zinc

Nitrogen/Phosphorus: ammonia, hydrazine, nitrate, nitrite, ortho-/total phosphate, phosphonate, quaternary ammonium compounds (QAC)

Special tests: acidity, carbon dioxide, chemical oxygen demand (COD), color, dissolved oxygen, dissolved solids, pH, suspended solids, turbidity

Toxics: arsenic, cyanide-containing compounds

Organics: gasoline, lignin, phenol, SBMDT, surfactants (detergent), tannin, triazole

Anions: bromide, chloride, chromate, fluoride, iodide, sulfate, sulfite

Other: boron, bromine, chlorine, chlorine dioxide, hydrogen peroxide, hydrogen sulfide, iodine, ozone, silica

Kit Prices

Color wheel comparator kits range from $76.00 (pH) to $205 (trace nitrite). Each of the kits is designed to perform 100 tests of the specific parameter. Color wheel comparator kits can also be used with the Hellige Aqua Tester (a visual comparison device for low concentrations); these complete kits (Aqua Tester plus specified parameter) range from $346 (pH) to $500 (gasoline).

Digital spectrophotometer kits range from $447 (iron) to $495 (aluminum).

THE KAHL SCIENTIFIC KITS

Kahl Scientific
P.O. Box 1166
El Cajon, California 92022
(619) 444-2158

Types of Kits Available

Color wheel device for comparing solutions

Principal Tests Available

Alkaline earths: alkalinity, total hardness

Metals: chromium, copper, iron, manganese

Nitrogen/Phosphorus: ammonia, nitrate, nitrite, ortho-/total phosphate

Special tests: acidity, carbon dioxide, color, dissolved oxygen, pH, suspended solids, turbidity

Toxics: none listed in catalog

Organics: none listed in catalog

Anions: chloride, chromate, fluoride, sulfate

Other: bromine, chlorine (total), hydrogen sulfide, silica

Kit Prices

The portable wastewater analysis kit uses a color wheel comparator and is designed to measure chlorine, dissolved oxygen, temperature, and pH. Reagents are supplied for 100 analyses of each parameter. This kit costs approximately $220.

Portable Laboratories

Kahl offers a portable laboratory for water analysis which permits direct reading of spectrometric, conductometric, and titrametric measurements, provides 27 common tests, and is expandable to 41 extra tests. This Portable Laboratory Kit sells for $2147. A scaled-down version of this kit, the WaterLab Test Kit, tests for 23 parameters and sells for $1592.

THE LAMOTTE CHEMICAL KITS

LaMotte Chemical
P.O. Box 329
Chestertown, Maryland 21620
(301) 778-3100

Types of Kits Available

Glass tubes for comparing solution colors
Dropper-type titrator
Colorimeter

Principal Tests Available

Alkaline earths: alkalinity, calcium, hardness

Metals: aluminum, cadmium, chromium, copper, heavy metals, iron, lead, manganese, molybdenum, nickel, potassium, silver, sodium, zinc

Nitrogen/Phosphorus: ammonia, hydrazine, nitrate, nitrite, organophosphonate, phosphate, polyphosphate, quaternary ammonium compounds (QAC)

Special tests: acidity, carbon dioxide, chemical oxygen demand (COD), color, dissolved oxygen, dissolved solids, pH, turbidity

Toxics: cyanide, cyanuric acid

Organics: amine (filming), detergents, EDTA/NTA, formaldehyde, phenol, SDMBT, tannin

Anions: chloride, chromate, fluoride, molybdate, sulfite, sulfate

Other: bromine, caustics, chlorine (free/total), chlorine dioxide, hydrogen peroxide, hydrogen sulfide, iodine, ozone, silica

Kit Prices

Glass tube comparators range from $20 (bromine test) to $99 (combination chlorine-pH test). Reagent refills are available.

Direct readout titrators range from $14 (total hardness test) to $49 (EDTA). Drop count titrators range from $12 (hardness) to $24 (organophosphonate). Reagent refills are also available for these kits.

Kits using a colorimeter ($332) are available from $8 (phosphate, high) to $31 (nickel).

Portable Laboratories

LaMotte will put together any combination of water test outfits. They also offer various portable laboratories ranging from $40 (alkalinity, chloride, hardness, sulfite) to $1341 (15 tests).

THE SOILTEST KITS

Soiltest, Inc.
2205 Lee Street
Evanston, Illinois 60202
(312) 869-5500
(800) 323-1242

Types of Kits Available

Glass tubes for comparing solution colors

Portable spectrophotometer

Principal Tests Available

Alkaline earths: alkalinity, hardness

Metals: aluminum, chromium, copper, iron, lead, manganese, zinc

Nitrogen/Phosphorus: ammonia, hydrazine, nitrate, ortho-/total phosphate

Special tests: acidity, color, dissolved oxygen, pH, suspended solids, turbidity

Toxics: hydrogen cyanide

Organics: surfactant (detergent)

Anions: chloride, chromate, fluoride, sulfate, sulfite

Other: chlorine, gasoline colorant, silica

Kit Prices

Most glass tube comparator kits cost $66. These kits use the Water Tester comparator, which costs approximately $330.

Water Analyzer Kits range from $9 (copper) to $38 (phosphate, all forms). Each kit has sufficient reagent to perform 50-100 analyses. The digital spectrophotometer needed for these kits costs approximately $490.

Soiltest offers different specialty outfits such as the limnology kits, which range from $196 (basic limnology kit) to $274 (Water Pollution I kit).

THE TAYLOR CHEMICALS KITS

Taylor Chemicals, Inc.
31 Loveton Circle
Sparks, Maryland 21152
(301) 472-4340
(800) 638-4776

Types of Kits Available

Glass tubes for comparing solution colors

Dropper-type titrator

Principal Tests Available

Alkaline earths: alkalinity, total hardness

Metals: aluminum, chromium, copper, iron, manganese, nickel, zinc

Nitrogen/Phosphorus: ammonia, hydrazine, nitrate, nitrite, phosphate, phosphonate, polyphosphate, quaternary ammonium compounds (QAC)

Special tests: acidity, carbon dioxide, color, dissolved oxygen, pH, total dissolved solids

Toxics: none listed in catalog

Organics: diethylethanolamine (DEEA), EDTA, octadecylamine (ODA), SDMBT

Anions: chloride, chromate, fluoride

Other: bromine, chlorine (free/total), hydrogen sulfide, iodine, ozone, silica, sulfate, sulfite

Kit Prices

The glass tube comparator kits range from $44 (chromate test) to $138 (ozone test). Each kit includes all reagents, tubes and color standards necessary to make evaluations.

Dropper-type titrator kits range in price from $5 (pH test) to $60 (combination tests). All kits have enough reagent to perform 50 tests.

Taylor Chemical has refill reagents available at less than complete kit cost; thus, costs per test run about $0.10 to $2.76. The company also has a variety of other color comparator kits which can be customized to fit any need. They also offer a water analyzer series for accurate determination of trace substances, by colorimetric method, which range from $85 (pH) to $150 (nitrate nitrogen).

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environment and cultural value of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

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