HACH COMPANY

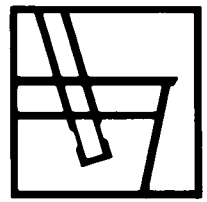
[redacted]

MANUAL

PORTABLE HACH ONE pH METER

MODEL 43800-00

4-15-90-5ED



SYSTEMS FOR ANALYSIS

AUTOMATIC ANALYZERS FOR

ALKALINITY
CHELANT
CHLORINE
CHLORINE DIOXIDE
CONDUCTIVITY
COPPER
HARDNESS
HEXAVALENT CHROMIUM
HYDRAZINE
IRON
MANGANESE^{7+}
pH
PHOSPHATE
POTASSIUM PERMANGANATE
SILICA

TURBIDIMETERS ▪ pH AND CONDUCTIVITY METERS
PORTABLE INSTRUMENTS ▪ PORTABLE TEST KITS
LABORATORY APPARATUS ▪ REAGENTS

HACH *The Analytical Methods Company*

HACH COMPANY
WORLD HEADQUARTERS
P.O. Box 389
Loveland, CO 80539 USA
Phone: (303) 669-3050
Telex: 160840
FAX: (303) 669-2932

HACH COMPANY
P.O. Box 907
Ames, Iowa 50010 USA
Phone: (515) 232-2533
FAX: (515) 232-1276

HACH EUROPE S.A./N.V.
B.P. 229
B5000 Namur 1, Belgium
Phone: 081/44.53.81
Telex: 846-59027
FAX: 081/44.13.00

International distributors and sales agents in principal cities worldwide ▪ Printed in U.S.A.

NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES

BUSINESS REPLY MAIL

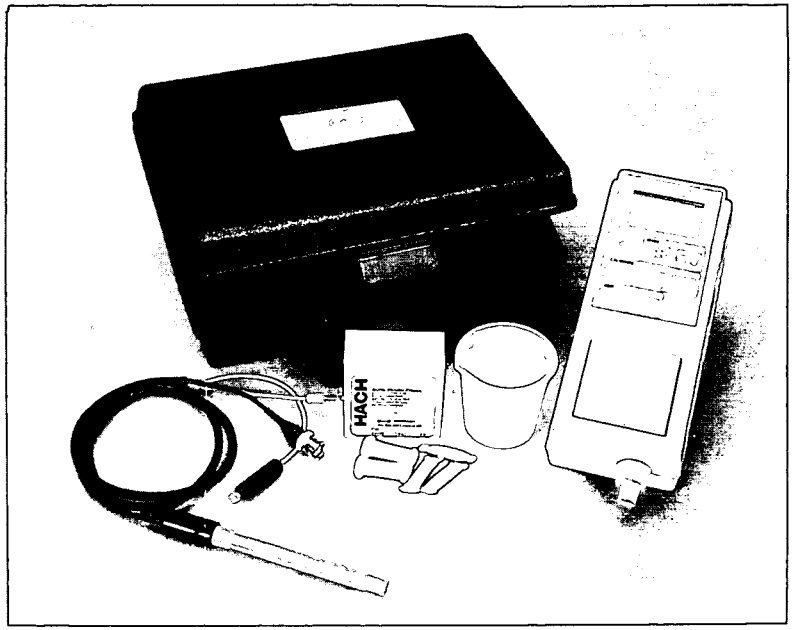
FIRST CLASS PERMIT NO. 100 LOVELAND, COLORADO

POSTAGE WILL BE PAID BY ADDRESSEE

HACH COMPANY

P.O. BOX 389
LOVELAND, CO 80539-9987

(Detach at perf, fold in half, tape and mail)



Model 43800-00 Portable Hach One pH Meter

CONTENTS

HACH COMPANY
P.O. Box 389
Loveland, CO 80539 U.S.A.

MANUAL
SUGGESTION FORM

Name _____

Street _____

City _____ **State** _____ **Zip** _____

Phone _____ **Date** _____

Your comments will assist us in improving the usefulness of our publications. Use this form to report error, omissions or suggestions.
Comments:

3. ADDRESS CHANGE

If your name, address or phone number has changed since your last order, please fill in all spaces in this section.

FIRM

FORMER ADDRESS

CITY STATE ZIP

FORMER NAME

FORMER PHONE NO. FORMER DEPT.

NO POSTAGE NECESSARY IF MAILED IN THE UNITED STATES

BUSINESS REPLY MAIL

FIRST CLASS PERMIT NO. 100 LOVELAND, COLORADO

POSTAGE WILL BE PAID BY ADDRESSEE

HACH COMPANY

P.O. BOX 389
LOVELAND, CO 80539-9986

(Detach at perf, fold in half, tape and mail)

ILLUSTRATIONS

SAFETY PRECAUTIONS

Before attempting to unpack, set up or operate this instrument, please read this entire manual. Pay particular attention to all warnings, cautions and notes. Failure to do so could result in serious injury to the operator or damage to the equipment.

USE OF WARNINGS, CAUTIONS AND NOTES

Warnings, cautions and notes used in this manual have the following significance:

WARNING

Failure to observe this information can result in personal injury or loss of life.

CAUTION

Failure to observe this information can result in damage to equipment.

Note

Information that requires special emphasis

Date_____

Hach Company

P.O. Box 389
Loveland, CO 80539

303/669-3050
800-227-4224

1. SHIP TO

FIRM

ADDRESS

CITY STATE ZIP

TO ATTENTION OF:

PHONE NUMBER DEPT.

☐ Send C.O.D.
☐ Prefer to send check with order. Will pay shipping charges on invoice.
☐ Charge purchase on open account: **Hach Account No.**

2. BILL TO

Purchase Order Number_____

FIRM

ADDRESS

CITY STATE ZIP

TO ATTENTION OF:

PHONE NUMBER DEPT.

Name of Item	Size	Cat. No.

Signature _____

3. ADDRESS CHANGE

If your name, address or phone number has changed since your last order, please fill in all spaces in this section.

FIRM

FORMER ADDRESS

CITY STATE ZIP

FORMER NAME

FORMER PHONE NO. FORMER DEPT.

NO POSTAGE NECESSARY IF MAILED IN THE UNITED STATES

BUSINESS REPLY MAIL

FIRST CLASS PERMIT NO. 100 LOVELAND, COLORADO

POSTAGE WILL BE PAID BY ADDRESSEE

HACH COMPANY

P.O. BOX 389
LOVELAND, CO 80539-9986

(Detach at perf, fold in half, tape and mail)

HACH

METER SPECIFICATIONS—MODEL 43800-00

RANGE

pH	-1.99 to 19.99 pH
millivolts	0 to ± 1999 mV
temperature	-5 to 105°C

RELATIVE ACCURACY

pH	± 0.01 pH
millivolts	± 0.10% of reading ± 0.2 mV
temperature	± 0.5° C

RESOLUTION

pH	0.01 pH
millivolts	0.1 mV (0 to ± 999.9 mV)
	1 mV (± 1000 mV to ± 1999 mV)
temperature	0.1° C

INPUT IMPEDANCE

10^{12} ohms

TEMPERATURE STORAGE RANGE

-40° C to 60° C (Electrode stored dry)

OPERATING TEMPERATURE RANGE

0 to 50° C

TEMPERATURE COMPENSATION RANGE

Measurements in pH Mode -5°C to 105°C
Automatic Buffer Recognition Calibration Mode 0°C to 60°C

OPERATING HUMIDITY

0 to 90% relative humidity, noncondensing

POWER SAVE FEATURE

The instrument powers down if a key has not been pressed within six minutes.

ELECTRODE

Model 44200-21 Hach One pH Electrode with Ag/AgCl Reference and Temperature Sensor; with BNC connector

POWER REQUIREMENTS

6 Volt J Battery

BATTERY LIFE

More than 40 hours under continuous use

SIZE

23L x 9W x 7cmH (9 x 3-1/2 x 2-1/2")

SHIPPING WEIGHT

1.8 kg (4 lbs)

(Specifications subject to change without notice.)

ELECTRODE SPECIFICATIONS—MODEL 44200-21

RANGE
0-14 pH units

ISOPOTENTIAL POINT
7 ± 0.2 pH

ELECTRODE RESISTANCE
Less than 100 megohms at 25° C (new)

TEMPERATURE RANGE

Continuous Use	0 to 45° C (32 to 113°F)
Intermittent Use	0 to 100° C (32 to 212°F)
Storage	-40 to 60° C (-40 to 140°F)

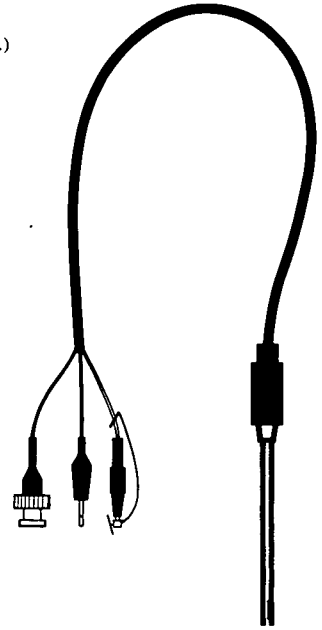
REFERENCE ELEMENT
Silver/Silver Chloride

ELECTRODE DIAMETER
10.5 mm (0.41")

ELECTRODE LENGTH
14 cm (5.5")

CABLE LENGTH
91.5 cm (36")

(Specifications subject to change without notice.)



Date_____

Hach Company
P.O. Box 389
Loveland, CO 80539
303/669-3050
800-227-4224

1. SHIP TO

FIRM
ADDRESS
CITY STATE ZIP
TO ATTENTION OF:
PHONE NUMBER DEPT.

☐ Send C.O.D.
☐ Prefer to send check with order. Will pay shipping charges on invoice.
☐ Charge purchase on open account: **Hach Account No.**

2. BILL TO

Purchase Order Number_____
FIRM
ADDRESS
CITY STATE ZIP
TO ATTENTION OF:
PHONE NUMBER DEPT.

Name of Item	Size	Cat. No.

Signature _____

APPENDIX C. TEMPERATURE VERSUS pH

Table 2. Temperature (°C) Versus pH of Hach Buffers

Buffer pH / Cat. No(s)	4.00 22269*‡ 22834*† 12223†	5.00 14097‡	6.00 14055‡	6.86 14098‡	7.00 22270*‡ 22835*† 12222†	8.00 14079‡	9.00 14107‡	9.18 14102‡	10.18 22271*‡ 22836*† 22221†
Temperature °C									
0	4.00	5.10	6.08	6.98	7.14	8.17	9.28	9.46	10.30
5	4.00	5.06	6.04	6.95	7.10	8.13	9.21	9.39	10.23
10	4.00	5.03	6.02	6.92	7.07	8.09	9.15	9.33	10.17
15	4.00	5.01	6.01	6.90	7.04	8.06	9.09	9.28	10.11
20	4.00	5.00	6.00	6.88	7.02	8.03	9.04	9.22	10.05
25	4.01	5.00	6.00	6.86	7.00	8.00	9.00	9.18	10.00
30	4.01	5.00	6.00	6.85	6.99	7.98	8.96	9.14	9.96
35	4.02	5.01	6.01	6.84	6.98	7.96	8.92	9.10	9.92
40	4.03	5.01	6.02	6.84	6.98	7.95	8.89	9.07	9.88
45	4.05	5.02	6.03	6.83	6.98	7.95	8.86	9.04	9.85
50	4.06	5.04	6.04	6.83	6.98	7.95	8.83	9.01	9.82
55	4.07	5.06	6.06	6.83	6.98	7.95	8.81	8.98	9.79
60	4.09	5.08	6.08	6.84	6.99	7.96	8.79	8.96	9.76

*Color-coded buffers
†Solutions
‡Powder pillows

QUICK START INSTRUCTIONS

The manual has complete instructions on preparing for use, calibration and measurement. Below is an outline of these instructions. Additional information may be found on the pages in parentheses.

INSTALLATION

1. Install battery. (12)
2. Install cartridge. (13)
3. Connect electrode. (15)
4. Turn the Priming Knob counterclockwise five complete turns.

SAMPLE MEASUREMENT (26)

1. Prepare the electrode(s) by soaking a minimum of two hours but preferably overnight in deionized water.
2. Open the pH 4.01 Hach Powder Pillow Buffer (red) with the clippers provided. Dissolved the contents in 50 mL deionized water using the included beaker. To stir the solution use the electrode. Rinse the electrode with deionized water after use.
3. Open the pH 7.00 Hach Powder Pillow Buffer (yellow) with the clippers provided. Dissolve the contents in 50 mL deionized water using the other beaker. To stir the solution use the electrode. Rinse the electrode with deionized water after use.

   (The buffers may be poured into a drain with running water when no longer needed.)
4. Press: [I/O] The display will light. If wrong keys are pressed, etc., at any time during a sequence of steps, press [I/O] to turn off the meter and start over with this step.

   (The meter will go blank if a key is not pressed during a six-minute interval.)

   (A detailed key description is found on pages 18 to 23.)
5. Press: [pH]
6. Press: [AUTO/MANUAL] The Auto indicator will light. Calibration in the automatic buffer recognition mode has been started.
7. Place the electrode into the pH 4.01 Hach Powder Pillow Buffer and press the Dispenser Button until it clicks.

8. Press: STANDARD and wait until the pH indicator stops flashing. The actual pH will appear in the display. If the solution temperature deviates from 25°C, the display will show the actual pH and not the labeled pH value.

9. Rinse the electrode, and repeat Steps 7 to 8 with the pH 7.00 Hach Powder Pillow Buffer.

10. Press: pH The meter is now measuring pH.

11. Rinse the electrode with deionized water and place into the unknown sample. Press the Dispenser Button until it clicks. The display will show the sample pH. Read the sample pH value after the stability indicator  stops flashing.

DIAGNOSTIC MESSAGES

A more complete description of the error codes is found on page 50.

E 1 The probe voltage reading is out of range in the pH mode.

E 2 The deviation from the ideal pH slope of -59.2 mV/pH unit is greater than 30%.

E 3 The probe mV offset is greater than 120 mV or less than -120 mV.

E 4 The pH reading has not been recognized as one of the 4.01, 7.00 or 10.00 pH standards in the automatic buffer recognition mode.

E 5 Both calibration solutions have the same nominal pH value.

E 6 The voltage is less that -50 mV or greater than +50 mV while the millivolt mode is being zeroed.

E 7 The temperature is out of autocalibration range, 0 to 60 °C.

E 8 The millivolt reading is out of range, less than -1999 mV or greater than +1999 mV.

Prompting indicators are described on page 48.

A troubleshooting guide is found on page 52.

NOTES

A. Use round bottles with screw caps and a capacity of at least 30 mL. Prior to the test, use a 25-mL graduated cylinder and add 25 mL of deionized water to each bottle and mark the 25-mL level in the bottle. A special shaker rack and 10 sample bottles, Cat. No. 18614-00, are available from Hach.

B. If the soil water pH is 6.5 or higher, there is no need to conduct the buffer pH test because the results will be meaningless.

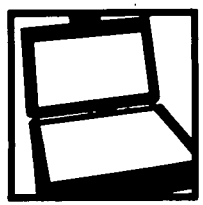
C. Table values are based on pure, fine $CaCO_3$. To determine the requirement of agricultural limestone or other liming materials, divide the table value by the $CaCO_3$ assay percentage of the liming material being used.

Reagents and Apparatus, See Part 5, Replacement Items and Accessories.

7. Consult the Lime Requirement Table to find the limestone recommendation corresponding to the buffer pH of each soil; see Note C.

Lime Requirement Table: Pure Limestone (as $CaCO_3$) Required

Buffer pH	Tons/Acre—8″ Depth	
	To pH 7	To pH 6.5
6.8	0.1	0.1
6.7	0.7	0.6
6.6	1.2	1.0
6.5	1.9	1.6
6.4	2.7	2.3
6.3	3.4	2.9
6.2	4.2	3.6
6.1	5.1	4.3
6.0	5.7	4.8
5.9	6.7	5.7
5.8	7.5	6.4
5.7	8.4	7.1
5.6	9.1	7.7
5.5	9.8	8.3
5.4	10.7	9.1
5.3	11.5	9.8
5.2	12.4	10.5
5.1	13.1	11.1
5.0	13.9	11.8
4.9	14.7	12.5



PART 1. PREPARATION FOR USE

UNPACKING

Remove the instrument and accessories from the shipping container and inspect each item for any damage that may have occurred during shipping. Verify that the following items are present:

Model 43800-00 Portable Hach One pH Meter
Model 44200-21 Combination pH Electrode with built-in Sensor
Beaker, 100 mL (2)
Battery, 6 volt, J type
Buffer Powder Pillows, pH 4.01 (red) and pH 7.00 (yellow)
Hach One Reference Electrode Solution Cartridge
Instruction Manual
Clipper, Large
Carrying Case

In addition to the accessories listed above, several items of optional equipment and apparatus are available from Hach; see Replacement Parts and Accessories, Part 5.

If any items are missing or damaged, please contact Customer Service in Loveland, Colorado, for instructions. Do not return the instrument without prior authorization. The toll-free number is 800-227-4224.

If you are located in Canada, Latin America, the Caribbean, the Far East or the Pacific Basin, please contact Hach Company, World Headquarters, P.O. Box 389, Loveland, Colorado 80539 U.S.A. Telephone (303) 669-3050, Telex 160840, FAX (303) 669-2932. Customers located in Europe, the Middle East or Near East, or in Africa, please contact Hach Europe, S.A./N.V., B.P. 229, B 5000 Namur 1, Belgium. Telephone (081) 44.53.81, Telex 846-59027, FAX (081) 44.13.00.

ASSEMBLY

Complete the following steps (Battery, Cartridge and Electrode Installation) to assemble the Hach One pH Meter.

BATTERY INSTALLATION

The 6-volt J battery supplied with the instrument must be installed. To install, remove from the plastic package and remove the battery cover from the bottom of the instrument.

Align the battery as shown in Figure 1. Slide the terminal end in first towards the contacts.

Equivalent replacement batteries are:

Duracell #7K67
Varta #4018T
Eveready #539

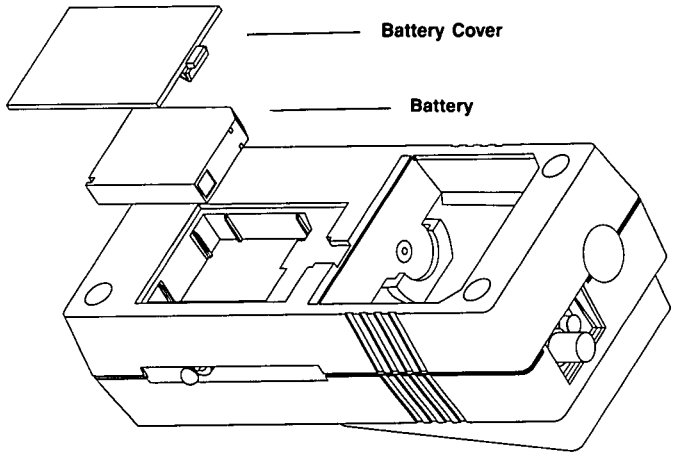


Figure 1. Battery Installation

WARNING

Battery may explode if recharged or disposed of in fire.

SOIL pH

Buffer pH, Lime Requirement
Using Lime Requirement Buffer 1 Powder
For 1:2.5 Soil Slurry

CALIBRATION

1. Calibrate the instrument by following instructions in Part 3, pH Calibration. Two buffer solutions are recommended (for instance, pH 4.01 and pH 7.00).

MEASUREMENT

2. Fill a 3.5-cc scoop with screened soil, tap the handle to settle the soil and strike off the excess with a spatula. Transfer two scoopfuls of each soil sample to bottles with screw caps; see Note A. Fill each bottle to the 25-mL mark with deionized water. Cap the bottle and shake for 30 seconds. Allow the sample to stand for at least 10 minutes after shaking.

3. Immerse the electrode in deionized water. Depress the DISPENSER BUTTON once to dispense reference solution. Then, immerse the electrode in the sample and stir briefly. Read the sample pH on the meter. This reading is the soil water pH (pHw); see Note B.

4. Add the contents of one Lime Requirement Buffer 1 Powder Pillow, Cat. No. 14345-98, to the sample bottle. Cap the bottle and shake for 30 seconds. Allow the sample to stand for 10 minutes.

5. Immerse the electrode in deionized water and depress the DISPENSER BUTTON once to dispense reference solution. Then, immerse the pH electrode in the sample bottle, stir briefly with the electrode and read the meter. This reading is the soil buffer pH (pHb).

6. After sample measurement, rinse the electrode with deionized water and store the electrode. See Part 3, Maintenance, for proper storage.

MEASUREMENT

3. Rinse electrode(s) thoroughly with deionized water.

4. Insert the electrode(s) into a clean 50-mL beaker containing 10 to 20 mL of sample. The glass bulb and junction tube must be immersed.

5. Dispense electrode solution and gently swirl or stir the sample.

6. Record the pH value after the reading stabilizes. This may take several minutes. Record the sample temperature and report it along with the pH.

7. The Hach One Electrode can be conditioned for low ionic-strength samples by immersing the electrode tip in deionized water and minimizing exposure to concentrated solutions such as buffers.

Reagents and Apparatus, See Part 5, Replacement Items and Accessories.

CARTRIDGE INSTALLATION

1. Press the PLUNGER RELEASE BUTTONS, Figure 2A, on the sides of the meter and slide the plunger all the way toward the PRIMING KNOB end of the meter; see Figure 2B. The plunger must be completely recessed in order to slide the cartridge in.

Note

Visually check the cartridge to see if crystals are present in the solution before installing a new cartridge in the meter in the following manner: hold the cartridge up to the light with tip down to view the clear plastic areas of the cartridge and invert several times. Crystals, if present, will be seen easily and interfere with later operation. Dissolve crystals by immersing the cartridge in warm water and shake the cartridge periodically until all crystals redissolve.

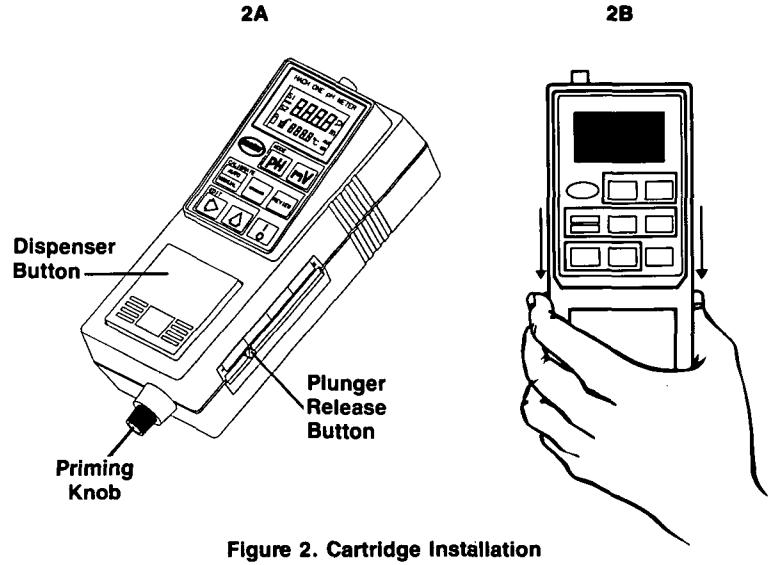


Figure 2. Cartridge Installation

2. Turn the meter upside down and slide the tip of the solution cartridge through the large opening in the meter base and then through the oval opening. See Figure 2C. Slide the flat end of the cartridge firmly into the semicircular slot in the meter; note the horizontal orientation of the tabs.

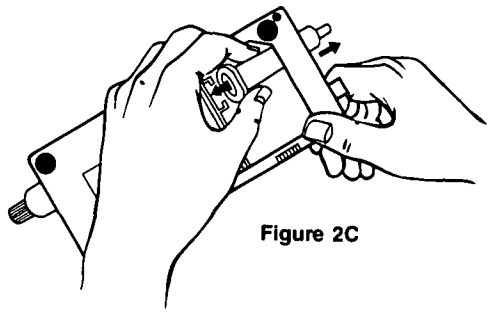


Figure 2C

3. Press the PLUNGER RELEASE buttons and slide the plunger toward the solution cartridge until it stops against the solution cartridge seal.

Figure 2D illustrates the Hach One Portable pH/mV meter assembled with the cartridge.

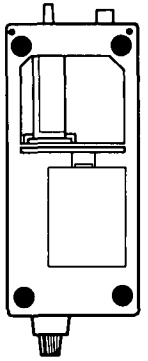


Figure 2D

APPENDIX B

RAINWATER AND ULTRAPURE WATER

The Hach One is ideally suited for rainwater and ultrapure water pH measurements. This procedure consists of three parts, calibration, control and measurement, in that sequence.

The electrodes should be conditioned in deionized water when not in use.

CALIBRATION

1. Calibrate the instrument by following instructions in Part 3, pH Calibration. Two buffer solutions are recommended (for instance, pH 4.01 and pH 7.00).

   Use either Hach Powder Pillows or National Bureau of Standards (NBS) Standard Reference Materials.

   SRM 185e (pH(s) 4.004 at 25°C) and SRM 186Ic/186IIc (pH 6.863(s) at 25°C) are available for purchase from:

   Office of Standard Reference Materials, NBS, Washington, DC 20234

CONTROL (OPTIONAL)

2. If required, electrode performance and calibration can be verified with rainwater reference samples such as NBS Simulated Rainwater, Reference Material 8409.

   a. Insert the electrode(s) into a clean 50-mL beaker containing 10 to 20 mL of the prepared rainwater reference solution.

   b. Dispense electrode solution and gently swirl or stir the sample. Stirring the sample continuously is recommended.

   c. When the reading has stabilized, record the pH value. Calculate the difference between the assigned pH value of the reference sample and the measured value. The difference should be less than 0.05 pH; if not, repeat the calibration and control sequence.

   d. Discard this sample.

The addition of the KCl changes the sample from a low ionic-strength solution to a moderate ionic strength solution. In one study‡ the above test was performed with the Hach One and other conventional electrodes. After the addition of the KCl, the Hach One stabilized at the same level as before the addition of KCl. Porous junction electrode potentials decreased by as much as 0.42 pH (25 mV); see Figure 16. The addition of ultrapure KCl to deionized water provides a quick, easy-to-perform performance check of the reference junction in an electrode. If the junction is allowing adequate flow or diffusion of electrode solution, the potential will change very little upon addition of KCl, less than 0.08 pH (5 mV). The Hach One is designed to provide junction potential stability, giving more accurate measurements, especially with low ionic-strength samples. Try this test with conventional porous junction electrodes after they've been in use for a few weeks!

‡Kopelove, Alan B.; Franklin, Stanley J., submitted for publication, "Performance Tests of Reference Junctions in Combination pH Electrodes," Hach Company, Loveland, Colo., 1986.

ELECTRODE INSTALLATION

Note

If the electrode(s) is new or has been in storage a long time, it should be conditioned prior to use by soaking overnight in deionized water. This is particularly recommended when preparing to measure low ionic strength solutions.

1. Twist and pull the cap from the solution cartridge tip and the plug from the end of the electrode tubing connector. Install the electrode tubing connector on the cartridge tip by pressing with a slight rotating motion. The cartridge tip cap can be stored on the electrode tubing connector plug.

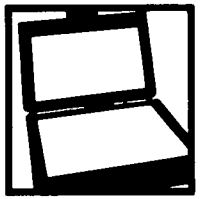
2. Remove the cap and cotton wad from the pH electrode tip. Examine the glass bulb to be sure it is filled with solution. The electrode will not function properly if an air bubble is in the bulb area. **Remove air by shaking down the electrode in the same manner as you would a clinical thermometer.** Replace the cap when the electrode is not being used.

3. Hold the meter so the cartridge tip points upward. Rotate the PRIMING KNOB **counterclockwise** until electrode solution emerges from the electrode tip. Five complete turns are necessary to purge all the air bubbles from the electrode tubing. **Failing to purge the system of air may result in erratic or inaccurate measurements.**

4. Immerse the glass bulb in the electrode tip in a beaker of deionized water and dispense a small amount of electrode solution by turning the PRIMING KNOB **counterclockwise**. The electrode should be held off of the bottom in order to observe the dense electrode solution sinking from the electrode tip. (Throughout this manual the term, deionized, refers to distilled, demineralized or deionized water.)

5. Connect the electrode BNC connector to the BNC receptacle on the Hach One pH Meter. Connect the temperature probe plug to the temperature probe jack.

6. Calibrate the pH meter as described Part 2, pH Calibration. During calibration and operation, a small amount of electrode solution should be dispensed each time the electrode is placed in a new sample. Depress the DISPENSER BUTTON until it clicks. This delivers 6 μL of electrode solution, a sufficient amount for most samples. Dispensing more electrode solution usually is unnecessary.



ELECTRODE STORAGE AND DISASSEMBLY

The Hach One Electrode can be stored dry in air without harm to the glass membrane. The glass will rehydrate quickly when immersed in water and an immediate response is obtained in concentrated solutions like calibration buffers.

Follow these steps to disassemble after use:

1. Remove the electrode from the sample and rinse with deionized water.

2. Cover the electrode tip with the cotton wad and black electrode cap. Lay the electrode down.

3. Disconnect the electrode tubing connector and insert the electrode tubing connector plug.

4. Tightly place the cartridge cap on the electrode solution cartridge.

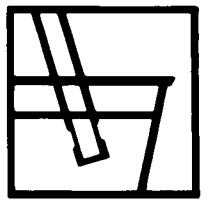
CAUTION

If the electrode solution cartridge is left installed in the instrument during storage or shorter periods of nonuse, be sure to install the cartridge cap **tightly**. Leaking electrolyte can cause corrosion damage to electronic parts.

5. Disconnect the BNC connector and the temperature probe.

6. Place the meter and the electrode into the case.

See Part 3, Maintenance for additional information on storage.



Thoroughly rinse the electrode(s) well with deionized water and measure solution B. If the reference junction is functioning properly and junction potentials are well-behaved, the meter should read 7.06 ± 0.01. In one recent study conducted by John Illingworth,* 30 electrodes were selected at random from seven laboratories. Twenty-four of the electrodes failed the test. Hach researchers found similar results. Errors as large as ±0.5 pH units were observed among older combination ceramic junction electrodes. Of the electrodes tested by Hach, only the Hach One Combination pH Electrode gave the correct pH value.

INFLUENCE OF IONIC STRENGTH

Illingworth also reported changes in sample ionic strength caused large pH errors in used combination electrodes.

He found a varying junction potential gave rise to an error of 0.2 pH per ten-fold change in buffer strength. Davison and Woof† tested electrodes with various dilute solutions and natural waters and found errors up to 2.6 pH.

A simple test demonstrating the influence of ionic strength on pH measurement is performed as follows.

1. Calibrate the electrode(s) as outlined in the above Checking Electrode Response section.

2. Place the electrode into 250 mL of stirring deionized water and allow the electrode response to stabilize. Note the pH reading.

3. Add 50 mg of ultrapure solid KCl. Allow the electrode response to stabilize. Note the pH reading.

*Illingworth, John A., "A Common Source of Error in pH Measurements," Biochemical Journal (1981) 195, 259-262. To receive a free reprint write or call Hach and ask for literature number 6061.

†Davison, W.; Woof, C., " Performance Tests for the Measurement of pH with Glass Electrodes in Low ionic-strength Solutions Including Natural Waters," Analytical Chemistry (1985), 57, 2567-2570.

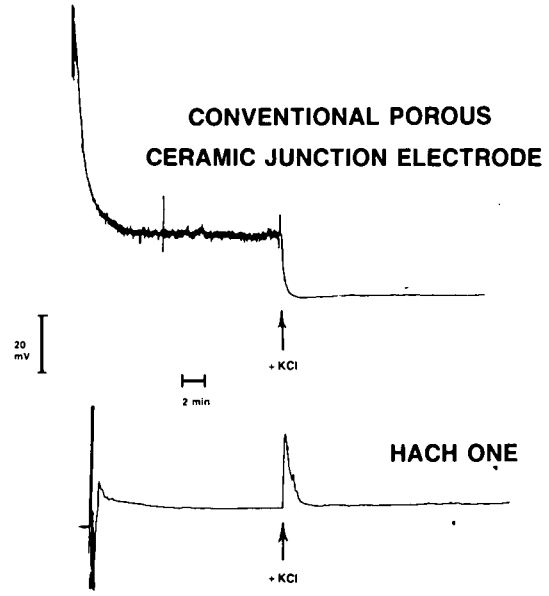


Figure 16. Influence of Ionic Strength on pH Electrode

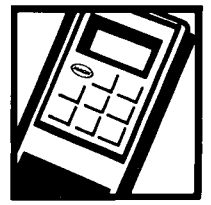
CHECKING ELECTRODE RESPONSE

The proper electrode response is relatively easy to check. Begin with a 6.86-pH buffer prepared by adding 3.388 grams of K_2PO_4 (potassium phosphate, monobasic) and 3.533 grams of Na_2HPO_4 (sodium phosphate, dibasic) to deionized water and dilute to one liter. Or, dissolve the contents of one Hach Buffer Powder Pillow (Cat. No. 14098) to 50 mL of deionized water. Label this solution A.

Pipet 5 mL of solution A to a mixing cylinder and add deionized water for a total volume of 50 mL. Label this solution B. Solution B is a 1-in-10 dilution of solution A.

Use solution A as the first buffer to calibrate the pH meter at 6.86 pH, 25°C.

Use a second buffer at pH 4.01 to calibrate the meter. The 4.01 pH buffer may be prepared by adding 10.12 grams of potassium hydrogen phthalate (potassium acid phthalate) to deionized water and diluting to one liter. Or, dissolve the contents of one Hach Buffer Powder Pillow (Cat. No. 22269) in 50 mL deionized water.



PART 2. OPERATION

INSTRUMENT DESCRIPTION

The Hach Model 43800 Portable Hach One™ pH Meter is a multipurpose microprocessor-controlled instrument with an integral Reference Solution Dispenser Pump.

It has been designed to measure pH, specific ion activity and millivolt potentials. The instrument will calculate, store, temperature compensate and display all parameters for pH measurements.

It has both automatic buffer recognition and manual calibration modes. The automatic buffer recognition mode uses pH 4.01, 7.00 and 10.00 Hach Powder Pillow Buffers. A two-buffer calibration may be used with any two of these buffers in any sequence. The manual mode may be used with any buffers, at least one pH unit apart, over the entire measurement range.

The Hach One pH Meter will provide direct digital readouts in pH units (-1.99 to 19.99) or millivolts (0 to ± 1999 mV). The four-digit display provides sensitive, accurate readings. If a temperature probe is attached, readings from -5 to 105°C may be obtained.

With the Hach One Combination pH Electrode and Temperature Sensor, the range is 0 to 14 pH units and the temperature range is 0 to 100°C.

Oxidation-reduction potential (ORP) and many ion selective electrodes may be used with calibration curves to correlate millivolt values with the constituent values.

DESCRIPTION OF OPERATING CONTROLS

Figure 3 illustrates the keys and indicators of the Hach One pH Meter. Functional descriptions of each are given in the accompanying table.

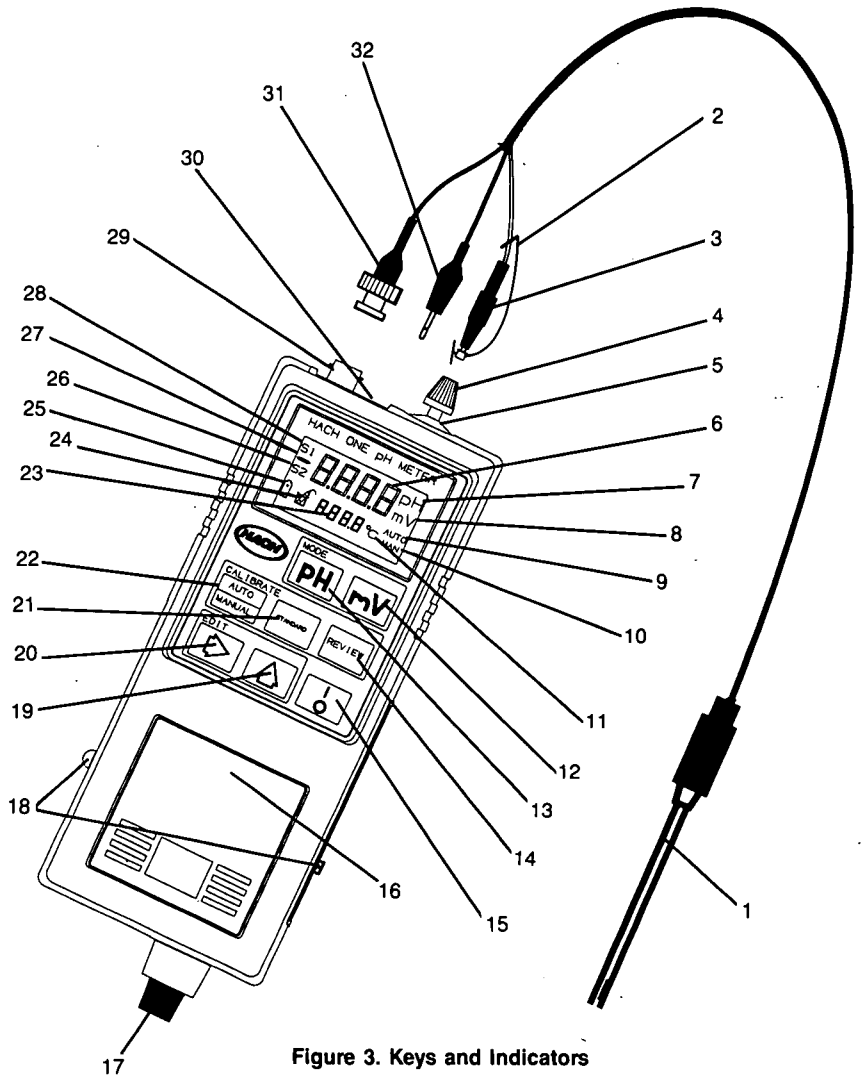


Figure 3. Keys and Indicators

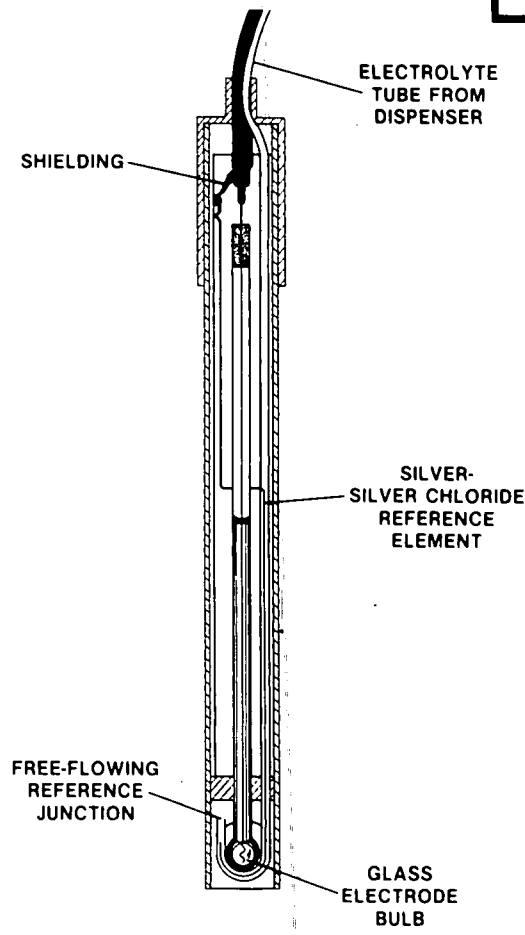
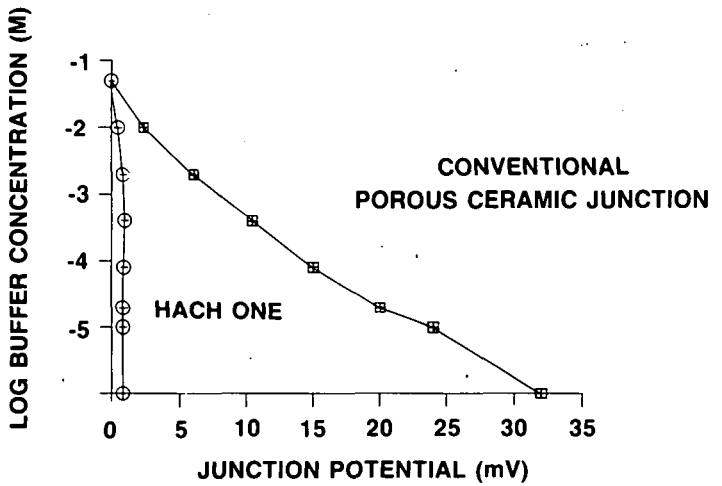


Figure 15. Hach One Combination pH Electrode

If the junction potential changes with the sample's ionic strength, the changes are read as part of the potential due to the hydrogen ion activity. This can cause an error in the pH reading. Figure 16 shows an aged conventional porous ceramic junction electrode (top) equilibrated in deionized water until a steady reading was obtained. The ionic strength was changed by adding a neutral salt, KCl. The apparent pH reading changed by 0.4 pH units. In the bottom graph the same electrode was retested, but with the reference electrode replaced by an aged Hach One reference electrode. Addition of KCl has little effect on the pH reading because the reference junction is stable.

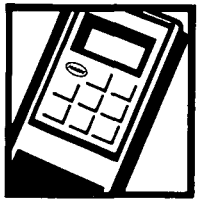
Figure 14. Junction Potential Compared to Buffer Strength



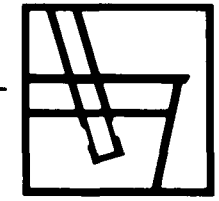
The porous junction of a conventional reference half-cell is made of ceramic or fiber. With time, the junction will become clogged with silver chloride or contaminants, causing large variation in the junction potential. In addition, reference solution can be contaminated or diluted by back diffusion of sample into the junction. Particulate contaminants may be introduced into refillable electrodes in the filling solution. Clogged or fouled junctions can cause drift along with inaccurate, noisy, erratic and sluggish pH measurements. The performance of conventional porous junctions deteriorates as they age because of clogging.

Hach One Electrodes solve this clogging problem because they use a continually renewed liquid junction; see Figure 15. There is no ceramic or fiber plug to become clogged. The free diffusion junction has been shown to give the most accurate results because of the stability of the junction potential.

Item	Name	Description
1.	Electrode (Probe)	Hach One Combination Electrode
2.	Electrode Solution Tubing	Tubing for electrode solution
3.	Connector & Plug	Attaches the electrode solution tubing to the electrode solution cartridge
4.	Cap	Used to prevent loss or contamination of electrode solution during storage
5.	Solution Cartridge	Contains electrode solution
6.	Display	LCD display of pH or mV values with two display modes, normal and editing. In normal display mode, the digits light; while in the editing display mode one of the digits will flash.
7.	pH Indicator	If the pH key, Item 13, is activated, the pH indicator will light. During calibration, flashes until reading is stable.
8.	mV Indicator	If the mV key, Item 12, is activated, the mV indicator will light.
9.	Auto Indicator	If the Auto/Manual key, Item 22, is activated in the pH mode, the Auto indicator will light. This shows that the meter is calibrating in the automatic buffer recognition mode.
10.	Man Indicator	If the Auto/Manual key, Item 22, is depressed again when in the pH mode, the Man indicator will light. This indicates the meter is in the manual calibration mode.
11.	°C	If lighted, it indicates the value shown in the temperature display, Item 23, has the units of degrees Celsius. If it is flashing, the temperature probe is not connected.



12.	mV Key	Millivolt mode key. When activated, the mV indicator will light and the display, Item 6, will read millivolts. The calibrate and edit keys as outlined on the keyboard will be inoperative. If a pH calibration is in progress, it will be canceled.
13.	pH Key	pH mode key. When activated, the pH indicator will light and the display, Item 6, will read pH units. If the pH key is depressed during a calibration, the calibration in progress will be lost. If the pH key is depressed at the completion of a calibration sequence, the appropriate values will be updated.
14.	Review Key	Calibration review key. Displays the offset and slope values used to determine the current calibration. The offset in millivolts will appear in the larger display with the mV indicator displayed. The slope in millivolts per pH unit will appear in the smaller display. Press again and return to the pH mode.
15.	Power Key	Turns on instrument power. Will need to be activated if a key has not been used within six minutes. If the key is depressed and held when the meter is turned on, all of the display symbols will appear.
16.	Dispenser Button	Used to dispense electrode solution from the cartridge.
17.	Priming Knob	Used to prime electrode solution cartridge. Turn counterclockwise to dispense solution.
18.	Plunger Release Buttons	Used to move dispenser plunger.



solutions. A second half-cell, or reference electrode, in contact with the sample solution is necessary to complete measurement of this potential difference.

The function of the reference half-cell is to maintain a constant potential with respect to the sample solution regardless of any change in ionic strength or pH of the sample. Thus, the reference half-cell maintains constant potential to act as a reference standard and the glass half-cell has a potential difference depending on the pH of the sample solution. Glass and reference half-cells may be contained in two separate enclosures or electrodes, or they may be combined into a single enclosure and called a combination electrode; see Figure 13.

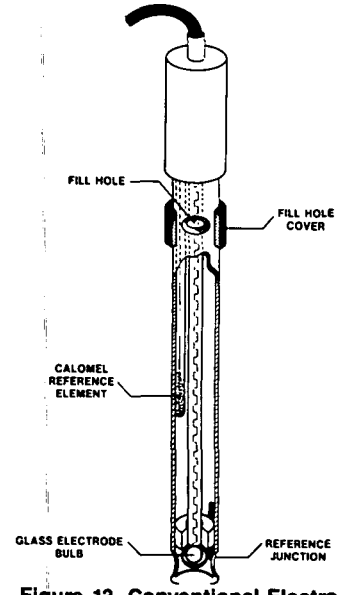


Figure 13. Conventional Electrode

Most electrode pH measurement problems are related to the failure of the reference half-cell to maintain constant potential. The problem is most obvious when making pH measurements on two sample solutions with a great difference in ionic strength. An example would be when a pH meter is calibrated with buffers of high-ionic strength and followed by measurement of a low ionic-strength sample, such as drinking water. The problem also exists in less extreme cases but errors in pH measurement result just the same. Figure 14 shows the variation in junction potential with log buffer strength for an aged Hach One and an aged porous ceramic junction electrode. The Hach One maintained a nearly constant potential, but the conventional electrode varied up to 32 mV as the sample changed from normal strength buffer to pure water. At 58 mV/decade this change would result in a difference of 0.5 pH units. To maintain a constant potential, the reference half-cell contains a concentrated salt solution, commonly potassium chloride (KCl). The reference solution must be able to flow freely to the sample from the half-cell via diffusion or through a flowing junction.

APPENDIX A

THEORY OF pH MEASUREMENT

Technically, pH is a measure of the hydrogen ion activity in a solution and is defined as: $-\log_{10} a_{H^+}$ where a_{H^+} is the activity of the hydrogen ion. Practically, this means that at pH 0, the hydrogen ion concentration is 1×10^{14} times greater than at pH 14. This also means the hydroxyl ion concentration at pH 14 is 1×10^{14} times greater than at pH 0. When the hydrogen and hydroxyl ions are present in equal numbers (the neutral point), the pH is 7. pH values from 0 to 7 are termed acidic and those from 7 to 14 are termed basic. It is important to note that a pH change of one unit (for instance from pH 6 to pH 7) actually is a factor-of-10 change in hydrogen ion concentration.

The glass membrane of a pH electrode responds to the hydrogen ion activity by developing an electrical potential at the glass/liquid interface. At a constant temperature, this potential varies linearly with the pH of the solution being measured. The change in potential per pH unit is termed the slope of the electrode. The slope of the electrode increases linearly with temperature.

Potential inside the pH electrode is fixed by the filling solution, and the reference electrode potential is constant. For these reasons, any change in the potential of the electrode system at a given temperature will be due to changes in the pH of the solution being measured.

Effects of temperature on pH measurements depend on the reference electrode used, pH of the solution within the pH electrode and pH of the test solution. At a certain pH, temperature will have no effect on the potential of the electrode system. This is known as the isopotential point. Also, at some pH level, the system will exhibit no potential. This is known as the zero potential point. Both the isopotential and zero potential points are features designed into electrodes. Hach electrodes are designed so the isopotential and zero potential points are at pH 7 to minimize temperature effects at this calibration point.

CONVENTIONAL ELECTRODE DESIGN

Electrodes used in pH measurement usually consist of a glass half-cell and a reference half-cell. The glass half-cell is a thin glass membrane separating two solutions. The outer solution is the sample to be tested. The internal solution is enclosed with the glass membrane and has a known pH. An electrical potential difference appears between the two

19. Up Arrow Key — Each press and release of the Up Arrow key increments the flashing number when in the editing mode. The range for the left-most digit in the display is 0 to 1 to 0. The range for the left-most digit in the temperature display is 0 to 1 to - to 0. The range for all the other digits is 0 to 9 to 0. The internal software will not allow the user to enter an inappropriate value. An example is entering 110 in the temperature display. The 110 is out of the -5 to 105°C range and cannot be entered. To enter 104 the zero and the four must be entered first. The Right Arrow key is then advanced and the one entered. This procedure is unnecessary for the pH display.

20. Right Arrow Key — Moves the flashing number to the next right digit. If the temperature probe is not connected, it will initiate editing of the temperature display. Increment this digit with the Up Arrow key or if it is a leading blank, a flashing zero, press the Right Arrow key to advance to the next digit.

21. Standard Key — Initiates reading of a buffer used in a calibration sequence.

22. Auto/Manual Key — Selects the calibration mode, either the automatic buffer recognition mode or manual buffer entry mode, and starts the calibration sequence.

Press once: Initiates the automatic buffer recognition calibration mode. The Auto indicator will light. The meter has been preprogrammed for using Hach Powder Pillow Buffers labeled pH 4.01, 7.00 or 10.00 in any order to calibrate the instrument.

Press again: Initiates the manual buffer entry mode. The Man indicator will light. The editing mode will be initiated with the left-

most digit flashing. If the temperature probe is not connected, the temperature may be edited as well.

23. Temperature Display — Continuously displays the temperature in 0.2 inch digits. When the temperature probe is not connected, the meter uses the last manually entered temperature or 25°C. The meter uses the displayed value to compensate the pH reading automatically for temperature. The letters, HI, will appear if the temperature is greater than 105°C. LO will appear if the temperature is less than -5°C.

24. Probe Indicator — Flashes until the reading is stable. In low ionic-strength samples it may take up to three minutes. If the instability is due to the probe or sample, it will continue to flash. Corrective action is needed; see Troubleshooting, Part 4. If the indicator is lighted but not flashing, the last calibration offset deviation was in the range of 60 to 120 mV and/or the slope deviated from -59.2 mV/pH unit by 15 to 30%. It will remain lighted until a new calibration is completed.

25. Battery Indicator — The battery indicator will light up when the voltage becomes low. When the voltage becomes too weak to operate the meter circuits, the instrument will turn itself off while maintaining calibration data in memory.

26. S2 Indicator — The S2 indicator will flash during a calibration when the second standard of a calibration is expected. The S2 indicator will light when the information on the display refers to the second standard.

27. Minus Sign — The minus sign will light when the meter reads a negative value.

WARRANTY

Hach warrants the Hach One pH Meter and the Hach One Combination Electrode against defective materials or workmanship for one year from the date of shipment. Warranties do not apply to limited life components such as batteries.

Hach's Terms and Conditions of Sale are printed on the back of Hach invoices.

CLAIMS

We take extreme care to fill and pack orders properly. If errors or damages do occur, report shipping damage to the carrier immediately and contact the Hach Customer Service Department as soon as possible (always within two weeks of receipt).

RETURN OF ITEMS

Authorization must be obtained from Hach before returning items for any reason. For credit or replacement, call toll-free 800-227-4224. All "Freight Collect" shipments of returned merchandise must be refused.

LIMITS OF USAGE

Our chemicals are offered for laboratory and manufacturing use ONLY. They may not be used as drugs, cosmetics or food additives.

Customers located in Europe, the Middle East or Near East, or in Africa, please contact:Hach Europe, S.A./N.V.

B.P. 229
B5000 Namur 1
Belgium
Telex: 846-59027
Telephone: (32)(81)44.53.81
Fax: (32)(81)44.13.00

For bulk quantities and custom chemical products and for questions not related to ordering or service, contact:

HACH WORLD HEADQUARTERS
Toll-free: 800-227-4224 (Continental U.S.A.)
Outside Continental U.S.A.: 303-669-3050

For factory service see Repair Service section.

REPAIR SERVICE

For assistance concerning service on your instrument, please contact the Hach Factory Service Center in Ames, Iowa first for arrangements. Call toll-free 800-227-4224. If you are located in Canada, contact instead the Hach Instrument Service Center, Winnipeg, Manitoba for arrangements. The toll-free number is 800-665-7635.

Hach Factory Service Center
Hach Company
100 Dayton Ave.
P.O. Box 907
Ames, IA 50010
(515) 232-2533
FAX: 515-232-1276

Hach Canada Service Centre
Hach Company
1313 Border Street, Unit 34
Winnipeg, Manitoba
R3H 0X4
(204) 632-5598
FAX: (204) 694-5134

In Latin America, the Caribbean, the Far East or the Pacific Basin, please contact Hach Company, World Headquarters, P.O. Box 389, Loveland, Colorado U.S.A. 80539 U.S.A. Telephone (303) 669-3050, Telex 160840. Customers located in Europe, the Middle East or Near East, or in Africa, please contact Hach Europe, S.A./N.V., B.P. 229, B5000 Namur 1, Belgium. Telephone (081) 44.53.81, Telex 846-59027, FAX (081) 44.13.00.

28.	S1 Indicator	The S1 indicator will flash during a calibration when the first standard of a calibration is expected. The S1 indicator will light when the information on the display refers to the first standard.
29.	BNC Receptacle	Attachment for BNC connector.
30.	Temperature Probe Jack (recessed)	Attachment for temperature probe.
31.	BNC Connector	Attaches the electrode to the meter.
32.	Temperature Probe Plug	Attaches the temperature probe to the meter.

ELECTRODE DESCRIPTION

Hach One Electrodes feature a vastly improved design providing fast response and measurement accuracy; see Figure 4. Error due to variations in reference junction potentials caused by junction clogging has been virtually eliminated.

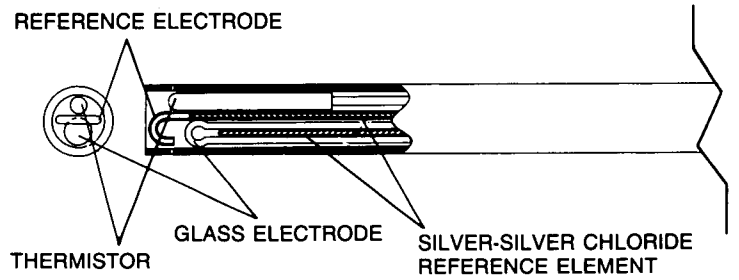


Figure 4. Hach One Combination pH Electrode with Temperature Sensor

Hach One pH Electrodes have silver-silver chloride reference elements. Electrode solution for the reference half-cell is metered through an open reference junction by using a special dispenser. One touch on the dispenser control button dispenses just the right amount of electrode solution through the reference junction. Electrode solution is dispensed through Teflon tubing which also encloses the silver-silver chloride reference element. Model 44250, the Hach One Reference Half-Cell Electrode, is available for use with two-electrode systems. Electrode solution for Hach One Electrodes is contained in disposable plastic cartridges to ensure fresh, contaminant-free solution.

The Hach One Electrode will provide greater accuracy and reliability for pH measurement than any other pH electrode available. Unique design and construction of Hach One Electrodes make them ideal for routine and special applications of pH measurement. Convenient for field or small-sample testing, the slim body of the Hach One (10.5 mm diameter) will fit into a 13-mm test tube for measurement of samples as small as 1.5 mL.

The Hach One uses a low-resistance glass so that it can be used down to 0°C. Although low-resistance glass hydrates easily, it has less durability at high temperatures. In addition, a moderate sodium error occurs at pH levels greater than 12 when low-resistance glass is used.

PRINCIPAL OF ELECTRODE OPERATION

Fresh electrode solution is dispensed from a cartridge through a free-flowing liquid junction as needed. Diluted electrode solution and contaminants are removed continuously from the vicinity of the junction. Build-up of junction potential, common with electrodes with porous plugs, does not occur with the free-flowing junction. Accordingly, samples of varying ionic strengths are measured accurately. The electrode solution is metered by a dispenser, controlled by a DISPENSER BUTTON, PRIMING KNOB and PLUNGER RELEASE BUTTONS. One push on the DISPENSER BUTTON triggers delivery of 6 μL of electrode solution from the cartridge. Hach One Electrodes provide quick, stable readings in a temperature range of 0 to 100°C (32 to 212°F). Intermittent use only is recommended above 45°C (113°F).

HOW TO ORDER

By Phone:
6:00 a.m. to 5:00 p.m. MST
Monday through Friday
Toll-free number: 800-227-HACH (800-227-4224) in U.S.A., Puerto Rico and U.S. Virgin Islands*.

By Mail:
Hach Company World Headquarters
P.O. Box 389
Loveland, Colorado 80539-0389 U.S.A.

By Telex:
160840 (Hach Loveland)

By Fax:
303-669-2932 (Hach Loveland)

Information Required:

- Hach account number (if available)
- Billing Address
- Shipping Address
- Your name and phone number
- Purchase order number
- Catalog number
- Brief description or model number
- Quantity

Outside the United States
Hach maintains a network of distributors and sales agents throughout the world.

In Canada, Latin America, the Carribbean, the Far East and the Pacific Basin, please contact:

Hach Company, World Headquarters
P.O. Box 389
Loveland, Colorado, 80539 U.S.A.
Telephone (303) 669-3050.
Telex: 160840
FAX: (303) 669-2932

*This number may not be available in some parts of Alaska and Hawaii; call 303-669-3050.

OPTIONAL APPARATUS

BNC to US Standard Adapter	43867-00
US Standard to BNC Adapter	23519-00
BNC Shorting Cap	19024-00
Demineralizer Bottle, 177 mL (6 oz)	14299-00
Electrode Holder and Stirrer Stand	45300-01
Electrode Holder Stand	45300-00
Hach One Combination pH Electrode with BNC connector, dispenser included	44300-01
Hach One Combination pH Electrode with BNC connector, without temperature sensor	44300-21
Hach pH Glass Half-Cell with BNC connector	44490-71
Hach One Portable ISE Meter	45400-00
Hach One Laboratory pH/ISE Meter	44700-00
Ion Selective Electrodes	
Complete Fluoride Analysis Package	13034-01
Hach Fluoride Electrode, BNC connector	44500-71
Hach Fluoride Electrode, US Std connector	44500-70
Complete Sodium Analysis Package	23481-00
Hach Combination Sodium Electrode, BNC connector	44520-21
Hach Sodium Glass Half-Cell, BNC connector	44520-71
Complete Nitrate Analysis Package	23482-00
Hach Nitrate Half-Cell, BNC connector	44560-71
Complete Potassium Analysis Package	23483-00
Hach Potassium Half-Cell, BNC connector	44530-71
Hach Combination ORP Electrode with BNC connector, dispenser not included*	44480-21
Hach ORP Half-Cell, BNC connector	44480-71
Hach One Reference Half-Cell, dispenser not included*	44250-20
Hach Double Junction Reference Electrode with Temperature Sensor, dispenser not included*	44551-20
Hach Double Junction Reference Electrode without Temperature Sensor, dispenser not included*	44550-20
Stainless Steel Temperature Probe, with BNC shorting cap	43976-00
Thermometer, armored, −10 to 110°C	1877-01

*Electrodes are available without dispenser because Hach pH and pH/ISE meters have built-in dispensers.

Applications for the Hach One Portable pH Meter include:

- Monitoring the pH of low ionic strength liquids such as ultrapure water and acid rain samples.
- Ecology studies of natural waters (lakes, rivers and streams).
- Water and wastewater treatment to monitor influent and effluent quality.
- Agricultural applications (soil, fertilizer, food and feed).
- Chemical and biological research.
- Industrial processes in the manufacture of foods, beverages, pharmaceuticals, dyes, photographic film and reagent grade chemicals.
- Medical laboratory studies of body fluids such as blood and urine.

OPERATION MODES

The three fundamental parameters measured by the Hach One Portable pH Meter are temperature, pH and millivolts.

TEMPERATURE MEASUREMENT

Temperature is measured only when the temperature probe is connected to the meter. If the temperature probe is not connected, the meter will display the last value entered manually or the default value of 25°C and the °C will flash. Temperature values may be changed by using the Up Arrow and Right Arrow keys when the temperature probe is disconnected.

Preliminary adjustments are not needed for taking temperature measurements. Once the probe is connected, immerse the probe tip in the test sample. Allow 30 seconds for the probe to stabilize and take the reading.

LABORATORY THERMOMETER

The Hach One pH Meter may be utilized as a laboratory thermometer with the purchase of a stainless steel temperature probe (Cat. No. 43976-00); see Figure 5. Simply plug in, attach the BNC shorting cap, and read the value in the temperature display. The BNC shorting cap stabilizes the erratic display.

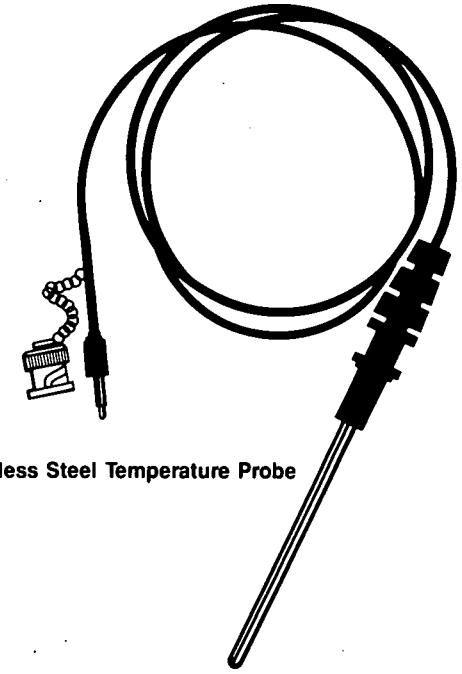


Figure 5. Stainless Steel Temperature Probe

With the stainless steel temperature probe, other pH probes may be used with the Hach One pH Meter and have automatic temperature compensation in the pH mode.

In the millivolt mode, oxidation-reduction potential and ion selective electrodes may be used. The temperature probe will provide an accurate measurement of sample temperature.

pH MEASUREMENT

pH is used to describe the hydrogen ion activity in a solution. The influence of the hydrogen ion activity in a solution on a pH electrode may be described by two parameters, offset and slope. A more complete explanation of pH is given in Appendix A, Theory of pH Measurement.

The offset is defined as the difference between the observed potential and the expected potential at pH 7.00. The default offset programmed into the Hach One Portable pH Meter is 0.00 mV.

PART 5. SERVICE

REPLACEMENT ITEMS AND ACCESSORIES

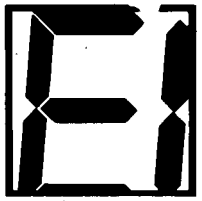
REPLACEMENT ITEMS

Description	Cat. No.
Portable Hach One pH Meter, Complete Kit	43800-00
Hach One Combination pH Electrode with Temperature Sensor, BNC Connector and (36") Cable	44200-21
Electrode Solution Cartridge	21950-01
Beaker, 100 mL (2 required)	22994-42
Battery, 6 volt J type or Duracell #7K67, Varta #4018T, Eveready #539	43816-00
Buffer Powder Pillows, pH 4.01 (red) and pH 7.00 (yellow) 10 each	22992-64
Instruction Manual	43800-88
Clipper, Large	968-00
Carrying Case	43875-00

OPTIONAL REAGENTS

Buffer, Powder Pillows	
pH 4.01, 50/pkg*, color-coded red	22269-66
pH 5.00, 15/pkg	14097-95
pH 6.00, 50/pkg	14055-66
pH 6.86, 15/pkg	14098-95
pH 7.00, 50/pkg*, color-coded yellow	22270-66
pH 8.00, 15/pkg	14079-95
pH 9.00, 50/pkg*	14107-66
pH 9.18, 15/pkg	14102-95
pH 10.00, 50/pkg*, color-coded blue	22271-66
Buffer Solutions	
pH 4.00, 473 mL (pt)*, clear solution	12223-11
pH 4.00, 473 mL (pt), color-coded red	22834-11
pH 7.00, 473 mL (pt)*, clear solution	12222-11
pH 7.00, 473 mL (pt), color-coded yellow	22835-11
pH 10.00, 473 mL (pt)*, clear solution	12221-11
pH 10.00, 473 mL (pt), color-coded blue	22836-11
Hydrochloric Acid Standard Solution, 0.1N, 946 mL (qt)	14812-16
Lime Requirement Buffer Powder Pillows 25/pkg*	14345-98
Sodium Hydroxide Standard Solution, 0.1N, 946 mL (qt)	191-16

*Larger sizes available.



OTHER POSSIBLE CONDITIONS

SLOW RESPONSE

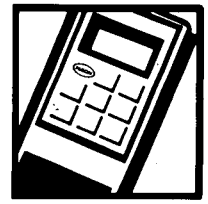
Low ionic-strength samples will cause a slower than normal response time, perhaps up to three minutes, in weakly buffered solutions from 10^{-3} M buffer to pure water. Conventional electrodes with porous junctions may require up to 40 minutes in similar low ionic-strength solutions. Clean the electrode glass bulb with a soft brush or towel. The glass bulb is easily scratched impairing electrode response. Therefore, clean carefully. Remove organic material from the electrode with acetone or alcohol. If acetone or alcohol is used, soak the electrode in deionized water for at least 30 minutes to quiet electrode response.

Response time may slow temporarily when the ionic strength of the measured solution changes greatly. The response time may be faster if the electrode is conditioned prior to use in a solution of approximately the same ionic strength. The length of time required to condition the electrode for different applications must be determined by the user. Two signs that conditioning is necessary are a probe indicator that flashes longer than usual and/or a slow drifting measurement over time. Drift may be due to volatile acids or bases in the sample, or absorption of atmospheric carbon dioxide, sulfur dioxide and ammonia.

INCORRECT TEMPERATURE READINGS

Verify the temperature probe is connected to the meter. Unplug the temperature probe and enter the desired temperature manually. Other alternatives would be to replace the electrode or substitute a separate temperature probe. If the °C flashes when the temperature probe is plugged in, the probe is defective. Either replace the probe or input the correct temperature with the Edit keys.

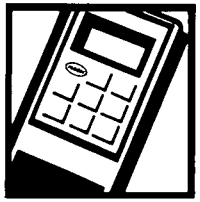
If the problem is still unknown, contact the Hach Service Center in Ames, Iowa. Call toll-free 800-247-3990.



The slope is defined as the change in potential per pH unit. The default slope programmed into the Hach One Portable pH Meter is -59.2 millivolts per pH unit.

These default values will change each time a calibration is performed. A one-buffer calibration will change only the offset, while a two-buffer calibration will change both the offset and slope.

The values used for offset and slope are as close as the touch of a button. In the pH mode the Review key, when pressed, will display the current offset in terms of millivolts in the display and the current slope in millivolts per pH unit in the temperature display. This data is invaluable to verify the accuracy of calibration and sample measurement over time. If the offset and slope exceed the normal expected calibration variations, the probe indicator will light. Larger variations will cause error messages to occur. These indicators and error messages are explained in more detail in the Troubleshooting section.



pH CALIBRATION

There are several ways to calibrate the pH meter. For the most accurate measurements, do a two-buffer calibration at least daily. A one-buffer calibration is less accurate but useful in routine applications. The factory or default calibration usually is the least accurate but the quickest to use.

Note

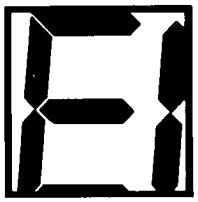
Electrode conditioning is important for accurate calibration for pH measurement. If the pH electrode to be used is new or has been in storage a long time, Hach recommends it be soaked overnight or at least several hours in deionized water before use. This will ensure the electrode will reach stability in a short time after being immersed in the standard solutions.

The Hach One pH Meter has been designed for these calibrations to be carried out in either an automatic buffer recognition (automatic) mode or a manual mode. In the following pH Calibration Procedure section each of these calibrations is described in detail. These calibrations include two-buffer calibration using automatic mode, two buffer calibration using manual mode, two-buffer calibration using automatic mode for one buffer and manual mode for the second buffer, one-buffer calibration using automatic mode, one-buffer calibration using manual mode and factory calibration.

In each procedure, bracketed steps, [ ], tell what action needs to be taken if the temperature probe is malfunctioning or not plugged in. The temperature may be entered using the Edit keys. In some situations it may not be necessary to enter a temperature if the currently displayed temperature is correct. Every three degrees Celsius difference between the displayed temperature and the actual solution temperature will cause a one per cent deviation per pH unit difference from pH 7. This means at pH 3 the effect of temperature on the pH measurement, when there is a difference in temperature from the display to the actual temperature, is more significant than at pH 6.

In all pH measurements, the results are only as good as the buffers used in the calibration procedure. Hach pH Powder Pillow Buffers are simple to prepare and accurate. Powder pillow packaging ensures the proper proportion of fresh, contaminant-free reagent. Prepare buffer solutions by:

1. Open the powder pillow with the clippers provided with the meter.



Step 3. Is it the meter or the electrode?

Verify that the meter is operating properly by zeroing the instrument with a steel paper clip as described in Part 2, Millivolt Zeroing. The meter is the least common source of error. If the meter zeros, the most probable source of error is the electrode.

Step 4. How to check the electrode.

1. Visually inspect the electrode for air bubbles in the reference junction and glass bulb. Air bubbles in either location will cause the electrode to malfunction. To remove air bubbles from the reference junction, use the Priming Knob to dispense additional electrode solution. To remove air bubbles from the glass bulb, shake the electrode down as you would a clinical thermometer.

2. Visually inspect the glass bulb for cracks or breakage. The electrode must be replaced if the glass bulb is cracked or broken.

3. Is the electrode solution flowing through the reference junction? Immerse the glass bulb in the electrode tip in a glass beaker of clear water and depress the Dispenser Button. You should see electrode solution falling from the electrode tip to the bottom of the beaker.

   If the electrode solution tubing is plugged, use a syringe attached to the electrode solution tubing connector to force air through the junction. Or, soak the probe in warm water.

4. Check the electrode electrical connections. Place the electrode in a solution of known pH. Gently flex the cable at the top of the electrode and at the BNC connector. Erratic readings at this point indicate a poor cable connection. The electrode must be replaced.

TROUBLESHOOTING GUIDE

Step 1. Is the display working?

Press and hold . Verify that all the segments are lighted. The display will appear as shown in Figure 12. Release . If not lit, replace the battery. Next, verify good connection with the battery terminals. Finally, return for service.

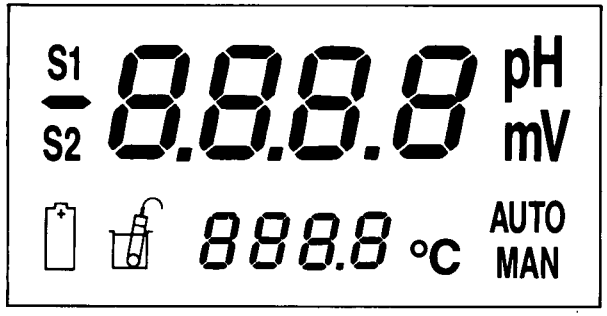


Figure 12. Display

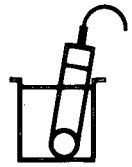
The display shows only partial digits, behaves in an erratic manner or if the instrument cannot be turned off with the power switch. Correct by removing the battery for a few seconds while the meter is on to restore the factory-set default conditions. If the condition persists, contact the Hach Factory Service Center.

Step 2. Are readings erratic?

In the event of a malfunction, verify that air bubbles have not stopped the diffusion of electrode solution at the junction. Five complete counterclockwise turns of the Priming Knob should purge the electrode solution tubing of all air bubbles. Air bubbles are the most common source of electrode malfunction.

2. Dissolve the contents of one powder pillow in 50 mL of deionized water and mix. See Part 5 for product ordering information and premixed solutions.

Accurate pH measurements are easy with the Hach One when the air bubbles in the electrode solution tubing are removed. Not removing all of the air bubbles is the most common technique error. Air bubbles are removed by dispensing more electrode solution with the Dispensing Button. More air bubbles can be removed by turning the Priming Knob counterclockwise.



If the probe indicator is lighted but not flashing during a calibration, it indicates a warning about the last calibration and not the current calibraton. The lighted indicator won't turn off until the current calibration is completed.

PROMPTING

The Hach One Portable pH Meter uses prompting indicators to direct the operator through calibration. When one of the program modes (automatic or manual calibration) has been selected, the instrument will prompt the operator as to the calibration requirements by flashing key indicators (S1 or S2) in the automatic calibration mode plus initiate editing of the display in the manual calibration mode; see Figure 6.

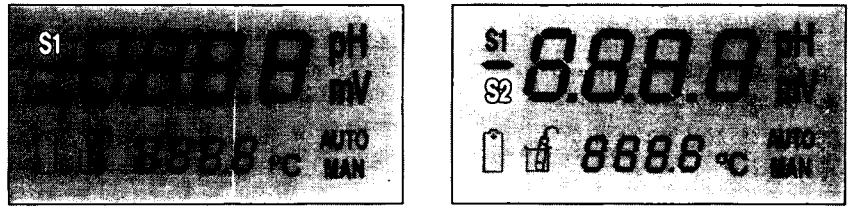


Figure 6. Prompting Indicators

pH CALIBRATION PROCEDURES

TWO-BUFFER CALIBRATION USING AUTOMATIC MODE

1. Press: The display will light.
2. Press: pH

3. Press: AUTO MANUAL The Auto indicator will light; see Figure 7. The S1 and pH indicators will flash. Zeros will appear in the display.

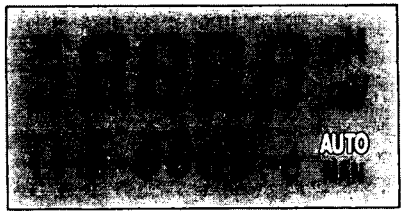


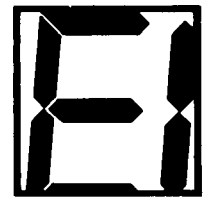
Figure 7. Auto Indicator

[If the temperature probe is not connected, determine temperature of the buffer. Press the Right Arrow key once and then enter the temperature using the Right Arrow and Up Arrow keys. The Right Arrow moves the flashing number to the next right digit, while the Up Arrow increments the flashing number. See page 21 for a detailed description of the Up Arrow key. The °C will continue to flash as long as a temperature probe is not connected.]

4. Place the electrode into a pH 4.01 Hach Powder Pillow Buffer and press the Dispenser Button. For best calibration, allow thirty seconds before pressing key in step 5. The temperature display will show the actual solution temperature throughout the entire sequence of steps if the temperature probe is connected.

5. Press: STANDARD and wait until the pH indicator stops flashing. The S2 indicator now will begin flashing. The actual pH value will appear in the display.If the solution temperature deviates from 25°C, the display will show the actual pH and not 4.01.

Fluctuating readings: If the screen displays a fluctuating reading or gives an E 1 error code, air bubbles in the electrode solution tubing are the cause. Air bubbles are removed by dispensing more electrode solution with the Dispensing Button. More air bubbles can be removed by turning the Priming Knob counterclockwise.



E 6 The voltage is read as less than -50 mV or greater than 50 mV while the meter is being zeroed in millivolt mode. Verify if the shorting clip was installed correctly and redo the Millivolt Zeroing Procedure. If still unable to zero, contact the Hach Factory Service Center.

E 7 The temperature is outside the range for automatic buffer recognition, 0 to 60°C. There are three different conditions that would cause this error code.

1. The electrode was placed in a buffer with a temperature outside of the range 0 to 60°C.

   a. Use the manual mode and input the correct temperature.

   OR

   b. Immerse the electrode tip into a buffer with an appropriate temperature and press the Standard key.

2. The temperature probe was not plugged in. The °C will be flashing as well. Plug in and press the Standard key.

3. The temperature probe is defective. The ° C will be flashing even though it is plugged in.

   a. Replace the probe.

   OR

   b. Follow the manual calibration procedure and input the correct temperature.

   OR

   c. Use a separate temperature probe (Cat. No. 43976-00).

E 8 The millivolt reading is less than -1999 mV or greater than +1999 mV. Verify the probe is connected and follow the suggestions for Unstable Readings in the Prompting Indicators section.

ERROR CODES

Error codes will appear as E followed by a value of one to eight. Each error code is listed with a description of the cause and the possible corrective steps.

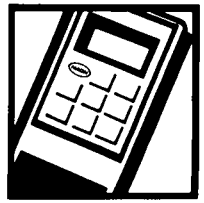
E 1 The probe voltage reading is out of range in the pH mode. It is greater than 19.99 pH or less than -1.99 pH. This will occur when the meter is turned on and/or the electrode is removed from a solution. It may correct itself when placed into a solution. If E 1 appears while in a solution, air bubbles in the electrode solution tubing are probably the cause. Air bubbles are removed by dispensing more electrode solution with the Dispenser Button. More air bubbles can be removed by turning the Priming Knob counterclockwise. Other corrective steps may be to change to mV mode or connect the electrode to the meter. In rare cases, air bubbles in the glass bulb are the cause; see Electrode Installation, Step 2.

E 2 The deviation from the ideal pH slope of -59.2 mV/pH unit is greater than 30%. Recalibrate with a two-buffer calibration or use previous calibration. To use the previous calibration turn the meter off, turn it on and press the pH key. The factory-set calibration may be used by removing the battery for at least five seconds while the meter is on.

E 3 The probe mV offset is greater than 120 mV or less than -120 mV. Recalibrate or use previous calibration. To use the previous calibration, turn the meter off, turn it on and press the pH key. The factory-set calibration may be used by removing the battery for at least five seconds while the meter is on.

E 4 The pH reading has not been recognized as one of the 4.01, 7.00 or 10.00 pH standards in the automatic buffer recognition mode. If appropriate, try the standard again by putting the electrode in a different solution.

E 5 Both calibration buffers have the same nominal pH value. The two pH buffers must be at least 1 pH unit apart. Recalibrate with different buffers or use previous calibration. To use the previous calibration, turn the meter off, turn it on and press the pH key. The factory-set calibration may be used by removing the battery for at least five seconds while the meter is on.



6. Rinse the electrode with deionized water.

   [If the temperature probe is not connected, determine the temperature of the buffer. Press the Right Arrow key once and then enter the temperature using the Right Arrow and Up Arrow keys. The °C will continue to flash as long as a temperature probe is not connected.]

   Place the electrode into a pH 7.00 Hach Powder Pillow Buffer and press the Dispenser Button. For best accuracy, allow 30 seconds to elapse before performing step 7.

7. Press: STANDARD S2 will stop flashing. Wait until the pH indicator stops flashing. The actual pH value will appear in the display. If the solution temperature deviates from 25°C, the display will show the actual pH and not 7.00.

Fluctuating readings: If the screen displays a fluctuating reading or gives an E 1 error code, air bubbles in the electrode solution tubing are the cause. Air bubbles are removed by dispensing more electrode solution with the Dispensing Button. More air bubbles can be removed by turning the Priming Knob counterclockwise.

Note

Pressing any key other than pH at this point in the calibration will cause the meter to revert to its previous calibration, and the new calibration just performed will be lost.

8. Press: pH Rinse the electrode with deionized water, place into sample and press the Dispenser Button. The meter now measures pH.

9. If desired, press: REVIEW Note the offset and slope used in determining pH. Press the Review key again to return to measuring pH.

   In the automatic buffer recognition mode, Hach Powder Pillow Buffers, pH 4.01, 7.00 and 10.00 may be used in any sequence.

TWO-BUFFER CALIBRATION USING MANUAL MODE

1. Press: I/O The display will light.

2. Press: pH

3. Press: AUTO MANUAL Two times. The Man indicator will light; see Figure 8. The S1 indicator, the left-most digit and the pH indicator will flash.

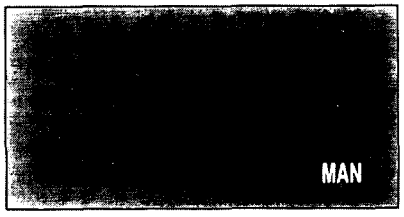


Figure 8. Man Indicator

4. Place the electrode into a standard buffer and press the Dispenser Button.

5. Determine the pH of the standard buffer at its current temperature from a table of values. The current temperature is shown in the temperature display if the temperature probe is connected. Appendix C has a table of Hach liquid and powder buffers showing temperature versus pH.

6. Use the Right Arrow and Up Arrow (▷ △ Edit keys) to enter the determined pH of the standard buffer in the display. The Right Arrow moves the flashing number to the next right digit, while the Up Arrow increments the flashing number. See page 21 for a more detailed description of the Up Arrow key.

   [If the temperature probe is not connected, determine the temperature of the buffer and enter it in the temperature display using the Right Arrow and Up Arrow. Use the Right Arrow to move the flashing number from the display to the temperature display. The °C will continue to flash as long as a temperature probe is not connected.]

Both of these conditions may be corrected by verifying there is adequate electrode solution at the junction and no air bubbles are present in the electrode solution tubing or glass bulb. Air bubbles in the electrode solution tubing are the most common problem.

The probe indicator will remain on if the calibration offset deviates from 0.0 mV by 60 to 120 mV and/or the slope deviates from the ideal slope of -59.2 mV/pH unit by 15 to 30%. Use the Review key to note the offset and slope. Correct a wrong offset by a one-buffer calibration. Correct a wrong slope and offset by a two-buffer calibration or return to the factory-set calibration.

LOW BATTERY

The battery indicator lights when the battery is low. When the voltage becomes too weak to operate the meter circuits, the instrument will turn itself off after two seconds while maintaining calibration data in memory. To save the calibration values during battery replacement:

1. Turn the meter off.

2. Have a replacement battery ready.

3. Switch batteries within 15 seconds.

UNCONNECTED TEMPERATURE PROBE

°C The °C indicator will flash if the temperature probe is not connected to the meter.

PART 4. TROUBLESHOOTING

Hach One pH Meter troubleshooting is easy. Four different tools are available. First, the offset and slope may be monitored using the Review key. Second, prompting indicators are used to display potential problems. Third, error codes have been designed to notify the user when the measurements are not performed accurately either due to operator error or to probe characteristic changes. These error codes are listed below. Fourth, a Troubleshooting Guide is provided. Common problems are solved easily by following these simple steps.

REVIEW KEY

In the pH mode the Review key will display, when pressed, the offset in millivolts in the display and the slope in millivolts per pH unit in the temperature display. For the Hach One Combination pH Electrode expect to see offset voltages deviating from 0.0 by 15 millivolts or less. The expected slope may deviate from -59.2 millivolts per pH unit by five percent. Values greater than these indicate the meter is unable to detect stable conditions. One alternative is to wait for 30 to 60 seconds before pressing the Standard key during a calibration. Another response is to clean the electrode as described in Part 3—Normal Electrode Cleaning.

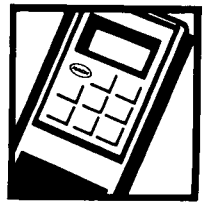
REVIEW

PROMPTING INDICATORS

UNSTABLE READINGS

During a calibration the pH indicator will flash indicating the reading is not yet stable.

During a pH measurement the probe indicator, in pH mode will flash if the pH reading is unstable.



7. Press: STANDARD and wait until the pH indicator stops flashing momentarily, about four seconds. The S2 indicator and the left-most digit now will begin flashing. Zeros or a previous calibration value will appear in the display to be edited, if necessary, for the second standard in Step 9.

Fluctuating readings: If the screen displays a fluctuating reading or gives an E 1 error code, air bubbles in the electrode solution tubing are the cause. Air bubbles are removed by dispensing more electrode solution with the Dispensing Button. More air bubbles can be removed by turning the Priming Knob counterclockwise.

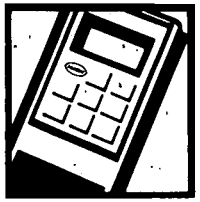
8. Rinse the electrode with deionized water. Place into a second standard buffer and press the Dispenser Button.

   [If the temperature probe is not connected, determine buffer temperature.]

   Determine the pH of the standard buffer at its current temperature from a table of values. Appendix C has a table of Hach liquid and powder buffers showing temperature vs. pH.

9. Use the Right Arrow and Up Arrow (▷ ⌂ Edit keys) to enter the determined pH value in the display.

   [If the temperature probe is not connected, enter buffer temperature using the Right Arrow and Up Arrow keys in the temperature display. Use the Right Arrow to move the flashing number from the display to the temperature display. The °C will continue to flash as long as a temperature probe is not connected.]



10. Press: STANDARD S2 will stop flashing. Wait until the pH indicator stops flashing.

    Fluctuating readings: If the screen displays a fluctuating reading or gives an E 1 error code, air bubbles in the electrode solution tubing are the cause. Air bubbles are removed by dispensing more electrode solution with the Dispensing Button. More air bubbles can be removed by turning the Priming Knob counterclockwise.

11. Press: pH Rinse the electrode with deionized water, place into sample and press the Dispenser Button. The meter now measures pH.

12. If desired, press: REVIEW Note the offset and slope used in determining pH. Press the Review key again to return to measuring pH.

TWO-BUFFER CALIBRATION USING AUTOMATIC MODE FOR ONE BUFFER AND MANUAL MODE FOR THE OTHER BUFFER

1. Press: I/O The display will light.

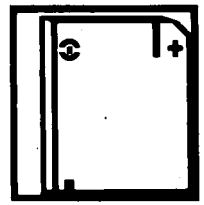
2. Press: pH

3. Press: AUTO MANUAL The Auto indicator will light. The S1 and pH indicators will begin flashing. The display will show all zeros.

4. Place the electrode into a pH 4.01 Hach Powder Pillow Buffer and press the Dispenser Button. The temperature display will show the actual solution temperature throughout the entire sequence of steps if the temperature probe is connected.

   [If the temperature probe is not connected, determine temperature of the buffer, press the Right Arrow key once and then enter the buffer temperature using the Right Arrow and Up Arrow in the temperature display. The Right Arrow moves the flashing number to the next right digit, while the Up Arrow increments the flashing number. The °C will continue to flash as long as a temperature probe is not connected.]

   In the automatic buffer recognition mode, pH 7.00 or 10.00 Hach Powder Pillow Buffers also may be used.



NORMAL ELECTRODE CLEANING

WARNING

The hydrochloric acid and sodium hydroxide used is this procedure may be hazardous if inappropriately handled or accidentally misused. Please read all warnings on the reagent labels.

When the electrode response becomes sluggish or the electrode is fouled, it should be cleaned. Normal cleaning procedures follow: immerse the electrode tip in 0.1N Hydrochloric Acid followed by immersion in 0.1N Sodium Hydroxide and again in 0.1N Hydrochloric Acid, each for a two-minute period. Rinse with deionized water; soak in deionized water for at least 15 minutes.

Oils and fats can be removed by immersing the electrode tip in a detergent solution such as Alconox. Use a soft brush or ultrasonic bath if necessary. Avoid scratching the glass bulb!

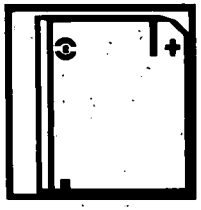
Organic films may be removed from the glass bulb by using an appropriate solvent, such as methanol or acetone.

If the glass bulb becomes contaminated, it may be reconditioned by following the above cleaning procedure.

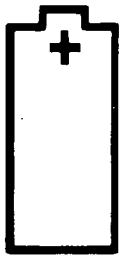
If these steps fail to improve electrode response, replace the electrode.

CRYSTAL FORMATION IN REFERENCE TUBE

The electrode solution for the reference portion of the electrode contains 2.2 N potassium chloride. Thus, temperature variations may cause crystals to form (which may interfere with free flow of electrode solution to the reference junction). These deposits are removed easily by immersing the area where crystals have developed in warm water (approximately 30°C or 86°F)for three to five minutes. If the crystals develop near the tip, immerse the electrode tip (or the entire electrode if necessary). If the area of blockage is unknown, the entire electrode and tube can be immersed. Do not immerse the instrument connectors. After the blocked area has been immersed for a few minutes, turn the PRIMING KNOB counterclockwise to flush electrode solution through the system. If crystals are present in the electrode solution cartridge, remove the cartridge from the meter, install the cap and immerse the cartridge in warm water. Shake the warmed cartridge periodically until all crystals are redissolved.



PART 3. MAINTENANCE



BATTERY REPLACEMENT

A low battery is signaled by the lighted battery indicator on the LCD display. When the voltage becomes too weak to operate the meter circuits, the instrument will turn itself off after two seconds while maintaining calibration data in memory. Replace the battery; see Part 1, Battery Installation.

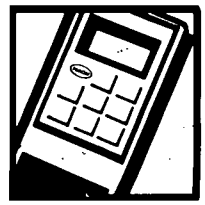
CARTRIDGE REPLACEMENT

To replace the electrode solution cartridge, press the PLUNGER RELEASE BUTTONS on the sides of the dispenser and slide the plunger all the way to PRIMING KNOB end of the meter. Remove the cartridge from the meter.

ELECTRODE STORAGE

The electrode may be allowed to air-dry during storage with no damage and need not be kept wet or immersed during storage. A dry electrode responds quickly to strong solutions, like buffers, within 15 minutes after being placed in service. For fastest response in dilute, low ionic-strength samples, the glass membrane can be stored in deionized water. Storage in deionized water is acceptable because the free-diffusion junction of the Hach One cannot be clogged by precipitated AgCl. Note: Storing any glass membrane in water causes gradual deterioration as ions are leached from the glass.

If the electrode is to be stored for an extended period of time it should be prepared as follows: Disconnect the electrode solution tubing from the solution cartridge. Using a syringe, inject approximately 20 mL of deionized water through the electrode solution tubing to flush out the electrode solution. Use a dry syringe to force air through the electrode solution tubing to dry it. Install the cap with the cotton wad on the end of the electrode. Do not add any solution to the cotton wad. Replace the plug in the end of the electrode solution tubing. Follow instructions in Part 1 to place the electrode in service again.



5. Press: STANDARD S1 will stop flashing. Wait until the pH indicator stops flashing. The S2 indicator will begin flashing. The actual pH value will appear in the display. If the solution temperature deviates from 25°C, the display will show the actual pH and not 4.01.

   Fluctuating readings: If the screen displays a fluctuating reading or gives an E 1 error code, air bubbles in the electrode solution tubing are the cause. Air bubbles are removed by dispensing more electrode solution with the Dispensing Button. More air bubbles can be removed by turning the Priming Knob counterclockwise.

6. Rinse the electrode with deionized water. Place into the second standard buffer and press the Dispenser Button.

7. Press: AUTO MANUAL The Man indicator will light.

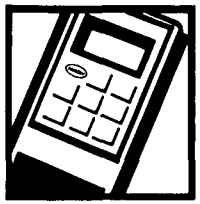
   The S2, the left-most digit and the pH indicator will begin flashing. Determine the pH of the standard buffer at its current temperature from a table of values. Appendix C has a table of Hach liquid and powder buffers showing temperature versus pH.

8. Use the Right Arrow and Up Arrow (▷ △ Edit keys) to enter the determined pH value in the display. The Right Arrow moves the flashing number to the next right digit, while the Up Arrow increments the flashing number.

   [If the temperature probe is not connected, determine the buffer temperature and enter it in the temperature display using the Right Arrow and Up Arrow. Use the Right Arrow to move the flashing number from the display to the temperature display. The °C will continue to flash as long as a temperature probe is not connected.]

9. Press: STANDARD S2 will stop flashing. Wait until the pH indicator stops flashing. The value entered in Step 8 will appear in the display.

   Fluctuating readings: If the screen displays a fluctuating reading or gives an E 1 error code, air bubbles in the electrode solution tubing are the cause. Air bubbles are removed by dispensing more electrode solution with the Dispensing Button. More air bubbles can be removed by turning the Priming Knob counterclockwise.



10. Press: pH Rinse the electrode with deionized water, place into sample and press the Dispenser Button. The meter now measures pH.

11. If desired, press: REVIEW Note the offset and slope used in determining pH. Press the Review key again to return to measuring pH.

    Calibration may also be done using the manual mode first and the automatic mode second.

ONE-BUFFER CALIBRATION USING AUTOMATIC MODE

1. Press: I/O The display will light.

2. Press: pH

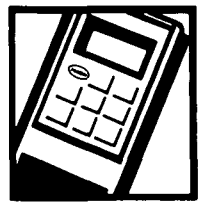
3. Press: AUTO MANUAL The Auto indicator will light.

4. Place the electrode into a pH 7.00 Hach Powder Pillow Buffer and press the Dispenser Button. S1 and pH indicators will be flashing. Zeros will appear in the display. The temperature display will show the actual solution temperature throughout the entire sequence of steps if the temperature probe is connected.

   [If the temperature probe is not connected, determine temperature of the buffer, press the Right Arrow key once and then enter the temperature using the Right Arrow and Up Arrow in the temperature display. The Right Arrow moves the flashing number to the next right digit, while the Up Arrow increments the flashing number. See page 21 for a detailed description of the Up Arrow key. The °C will continue to flash as long as a temperature probe is not connected.]

   In the automatic buffer recognition mode, Hach Powder Pillow Buffers, pH 4.01 or 10.00 also may be used.

5. Press: STANDARD S1 will stop flashing. Wait until the pH indicator stops flashing. S2 will begin flashing. The actual pH value will appear in the display. If the solution temperature deviates from 25°C, the display will show the actual pH and not 7.00.



3. Press and hold: mV
   Press and release: I/O
   Release: mV
   The mV indicator will light, and after about 10 seconds the meter will read 0.0 mV ±.2 mV.

4. If there is a meter malfunction that will cause the reading to be less than -50 millivolts or greater than 50 millivolts, the error message, E 6, will appear. Additional troubleshooting information appears in Part 4.

If the above procedure is used routinely, a BNC shorting cap (Cat. No. 19024-00) is recommended to prevent damage to the gold contact of the BNC connector. Hach recommends that zeroing be done only when deemed necessary by the user and/or when replacing the battery. The instrument has been designed to maintain zero.

Because of the millivolt range of -1999 to +1999 mV, the Hach One Portable pH Meter can be used with ORP (oxidation-reduction potential) probes and many ion selective electrodes.

MILLIVOLT MEASUREMENT

The Hach One Portable pH Meter may be used to read millivolts at any time by pressing the mV key. The mV indicator will light. With the proper probe, values from -1999 mV to 1999 mV may be read in this mode. If the reading is outside of this range the error message, E 8, will appear in the display.

For readings in the range of -999.9 to 999.9 mV, the meter will display tenths of millivolts. For readings outside of this range the meter will display readings to the nearest millivolt.

MILLIVOLT ZEROING

The meter may be zeroed for millivolt measurements by following this sequence:

1. Turn off the meter.

2. Insert the straightened end of the shortest bend of a No. 1, steel paper clip into the inner hole of the BNC receptacle; see Figure 11. Push the remainder of the paper clip so that it will slip into the inner sleeve of the receptacle. This will electrically short the BNC connector.

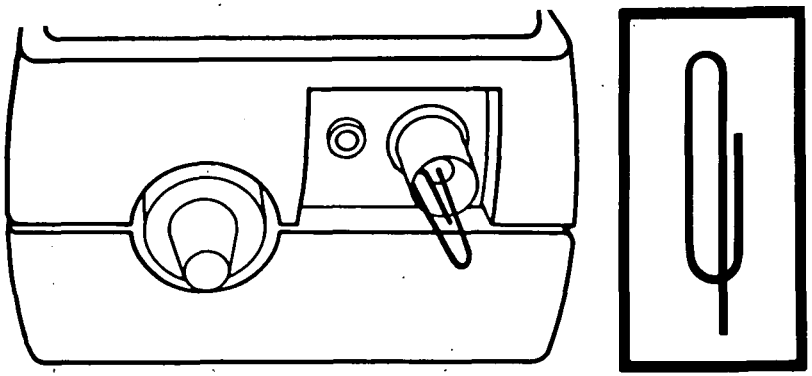


Figure 11. Zeroing the Hach One Meter

Fluctuating readings: If the screen displays a fluctuating reading or gives an E 1 error code, air bubbles in the electrode solution tubing are the cause. Air bubbles are removed by dispensing more electrode solution with the Dispensing Button. More air bubbles can be removed by turning the Priming Knob counterclockwise.

6. Press: pH Rinse the electrode with deionized water, place into sample and press the Dispenser Button. The meter now measures pH.

7. If desired, press: REVIEW Note the offset and slope used in determining pH. Press the Review key again to return to measuring pH.

ONE-BUFFER CALIBRATION USING MANUAL MODE

1. Press: I/O The display will light.

2. Press: pH

3. Press: AUTO MANUAL two times. The Man indicator will light. The S1 and pH indicators will begin to flash.

4. Place the electrode into a standard buffer and press the Dispenser Button.

   The left-most digit and the pH indicator will begin flashing. Zeroes or a previous calibration value will appear in the display to be edited, if necessary, in Step 5. Determine the pH of the standard buffer at its current temperature from a table of values. The current temperature is shown in the temperature display. Appendix C has a table of Hach liquid and powder buffers showing temperature vs. pH.

5. Use the Right Arrow and Up Arrow (▷ △ Edit keys) to enter the determined value in the display. The Right Arrow moves the flashing number to the next right digit, while the Up Arrow increments the flashing number. See page 21 for a detailed description of the Up Arrow key.

[If the temperature probe is not connected, determine temperature of the buffer and enter it in the temperature display using the Right Arrow and Up Arrow. Use the Right Arrow to move the flashing number from the display to the temperature display. The °C will continue to flash as long as a temperature probe is not connected.]

6. Press: STANDARD S1 will stop flashing. Wait until the pH indicator stops flashing momentarily, about four seconds. The value entered in Step 5 will appear. The S2 indicator and the left most digit now will begin to flash. Zeros or a previous calibration value will appear in the display and may be disregarded.

Fluctuating readings: If the screen displays a fluctuating reading or gives an E 1 error code, air bubbles in the electrode solution tubing are the cause. Air bubbles are removed by dispensing more electrode solution with the Dispensing Button. More air bubbles can be removed by turning the Priming Knob counterclockwise.

7. Press: pH Rinse the electrode with deionized water, place into sample and press Dispenser Button. The meter now measures pH.

8. If desired, press: REVIEW Note the offset and slope used in determining pH. Press the Review key again to return to measuring pH.

FACTORY CALIBRATION

To return the meter to the factory set offset of 0.00 mV and slope of -59.2 mV/pH unit, turn the meter on and remove the battery from the instrument for five seconds or longer. Use the Review key to verify these are the new default values.

STABILITY OF READINGS

The Hach One Meter has been designed to provide pH measurement stability information. During calibration the pH indicator flashes when the readings are unstable; see Figure 9A. During sample measurements in the pH mode, the probe indicator will flash when the measurements are unstable; see Figure 9B.

Drift

In weakly buffered alkaline solutions, absorption of carbon dioxide from the atmosphere is a major cause of downward drift of pH readings. Loss of volatile acids or bases may cause drifting as well. Drifting is minimized by covering the sample during measurement.

Sodium Error

Acid error is negligible and negative sodium error, usually present in alkaline solutions, is low, even at pH values as high as 12. To determine the sodium error in pH units, measure the apparent pH and sodium concentration of the test solution and determine the error from the Sodium Ion Error Graph in Figure 10. Do this by locating the point (on the appropriate pH horizontal grid line) representing the sodium concentration based on the extrapolation between the 229, 2,290 and 22,900-mg/L Na plots. The vertical grid line at that point will indicate the negative sodium error (in pH units) that should be added to the apparent pH meter reading.

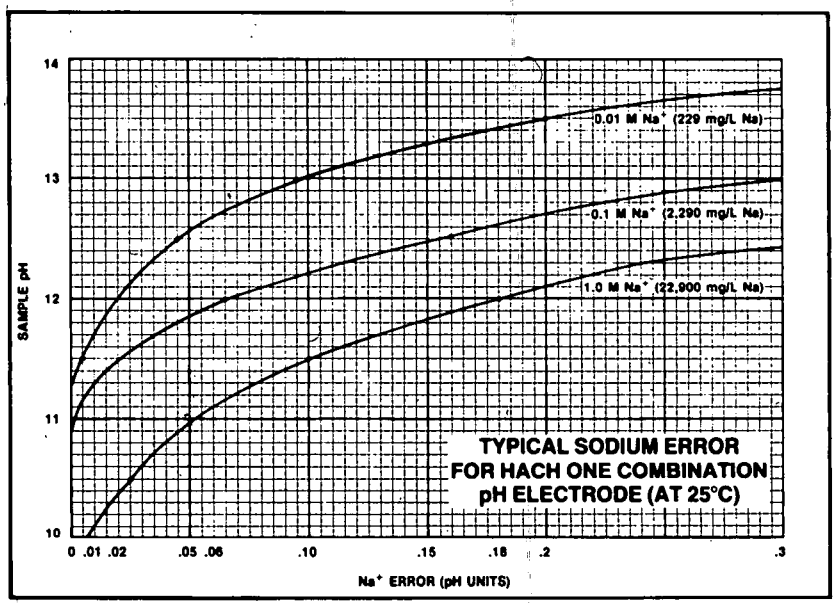


Figure 10. Sodium Ion Error Graph

Temperature Factors

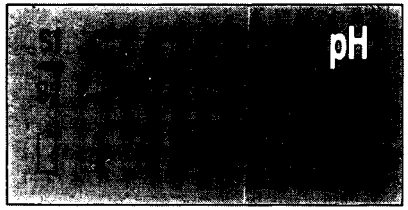
To optimize electrode performance, the electrode, buffers and test samples should be equilibrated at the same temperature prior to measurements. When transferring your electrode from one solution to another, rinse the tip thoroughly with the solution to be measured next or with deionized water.

Electrode solution cartridges that have been exposed to cold temperatures should be examined visually to be sure crystals, which could enter and obstruct the electrode solution tubing, have not formed inside the cartridge. If crystals are present, warm the cartridge, shaking it several times, until all crystals are redissolved.

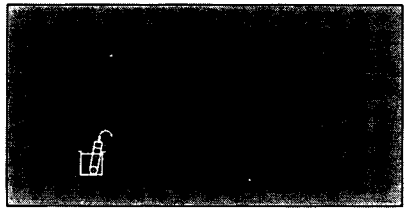
The electrode is intended for continuous use in samples with temperatures ranging between 0 and 45°C (32 to 113°F). Prolonged use at higher temperatures will shorten its useful life, but intermittent use up to 100°C has no noticeable effect. At temperatures near 0°C, the measurement time for the electrode will increase.

The electrode solution cartridge contains 2.2 N KCl saturated with AgCl in 40% glycerin to enable the electrode to withstand freezing conditions.

If the temperature probe is malfunctioning or not plugged in, the temperature may be entered using the Edit keys. In some situations it may not be necessary to enter a temperature if the currently displayed temperature is correct. Temperature influences two different factors in every pH measurement. One factor is the temperature of the silver-silver chloride reference elements and glass bulb. The Hach One pH Meter has been designed to compensate automatically for the electrical changes in the reference elements and glass bulb due to temperature. Because of this design, every three degrees Celsius difference between the displayed temperature and the actual solution temperature will cause a one percent deviation per pH unit difference from pH 7. This means at pH 3 the effect of temperature on the pH measurement, when there is a difference in temperature from the display to the actual temperature, is more significant than at pH 6. The second factor is the solution temperature. Though a solution is labeled a pH 4.01 buffer, the actual pH is 4.01 only at 25°C. At other temperatures the pH will vary slightly depending on the characteristics of the chemicals used in preparing the buffer. In the automatic buffer recognition mode, the Hach One pH Meter will give the actual pH value. In the manual calibration mode, a table must be consulted for the pH of the buffer at a given temperature.



9A



9B

Figure 9. Stability Indicators

SAMPLE PROCEDURE

Calibration and measurement are two fundamental steps in every pH measurement. Calibration, also called standardization, compensates for changes in the meter or electrode(s). Measurement determines the sample pH.

Calibration

1. Calibrate the meter by one of the pH calibration procedures described in the above pH Calibration section. The two-buffer calibration using the automatic buffer recognition mode with the temperature probe is recommended, see Note A for buffer preparation. Press the pH key when the calibration is completed.

Measurement

2. Rinse the electrode well with deionized water.

3. Place the electrode(s) in the sample to be tested. Depress the DISPENSER BUTTON once to dispense electrolyte. Stir the sample; see Note C. Read the pH value from the meter; the section on Optimizing Electrode Performance has additional helpful information. If CO_2 absorption is a concern, see Note B.

Fluctuating readings: If the screen displays a fluctuating reading or gives an E 1 error code, air bubbles in the electrode solution tubing are the cause. Air bubbles are removed by dispensing more electrode solution with the Dispensing Button. More air bubbles can be removed by turning the Priming Knob counterclockwise.

4. Rinse the electrode with deionized water after sample measurement.

Notes

A. pH buffer solution preparation is easy with Hach pH Powder Pillow Buffers. Powder pillow packaging ensures the proper proportion of fresh, contaminant-free reagent. Prepare buffer solutions by adding the contents of one powder pillow to 50 mL of deionized water and mix. Premixed pH buffer solutions also are available. See Part 5 for product information.

B. When measuring water with a low buffer capacity (such as boiler condensate or high purity natural water), it may be necessary to cover the solution during measurement to prevent change in the carbon dioxide concentration of the sample.

C. Stirring the sample with the Hach One during measurement is recommended. Slow to moderate stirring will speed the response and will not shift the potential—as can occur with conventional porous junction electrodes. For field measurements the sample may be stirred with the electrode. For lab measurements a magnetic stirrer and stir bar work best.

D. Do not immerse the electrode past the blue body of the probe in a solution.

Reagents and Apparatus—See Part 5, Reagents and Apparatus.

OPTIMIZING pH ELECTRODE PERFORMANCE

The greatest source of pH measurement error is a clogged reference junction. A clogged reference junction causes variation or irregularities in the liquid junction potential. The Hach One is designed so that the liquid junction potential is kept to a constant and minimal value.

Response Time

Normal response time in buffered solutions is only a few seconds. The response time will be slower, perhaps up to three minutes, in weakly buffered solutions from 10^{-3} M buffer to pure water. Conventional electrodes with porous junctions may require as much as 40 minutes in similar low-ionic strength solutions. Response time slows as the ionic strength and temperature decrease. If the response time becomes slower than usual, clean and soak the glass membrane in deionized water as described in Part 3, Maintenance-Normal Electrode Cleaning.

Storage

The Hach One can be stored dry in air without harm to the glass membrane. The glass will rehydrate quickly when immersed in water, and an immediate response is obtained in concentrated solutions like calibration buffers. For measurements in low ionic-strength samples, the electrode should be conditioned by immersion in deionized water.

Technique

It is better to stir the sample gently than to measure a still sample. Stirring the sample speeds the Hach One response dramatically in low ionic-strength samples. Conventional electrodes with ceramic junctions can give variable and shifted potentials upon stirring.

With the Hach One Electrode, press the Dispenser Button for more solution if the readings become erratic.