49732-88


# POCKET COLORIMETER™ Analysis System

## Generic Models

# Instruction Manual

 te/dk 6/01 2 ed

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# CERTIFICATION

Hach Company certifies this instrument was tested thoroughly, inspected, and found to meet its published specifications when it was shipped from the factory.

The Pocket Colorimeter™ instrument has been tested and is certified as indicated to the following instrumentation standards:

**EMC Immunity:**
Per **89/336/EEC** EMC**: EN 61326:1998** (Electrical Equipment for measurement, control and laboratory use—EMC requirements). Supporting test records by Hach Company, certified compliance by Hach Company.

**Standard(s) include:**
IEC 1000-4-2: 1995 (EN 61000-4-2: 1995) Electro-Static Discharge Immunity (Criteria B)
IEC 1000-4-3:1995 (EN 61000-4-3: 1996) Radiated RF Electro-Magnetic Field Immunity (Criteria A)

**Additional Immunity Standard(s) include:**
ENV 50204: 1996 Radiated Electro-Magnetic Field from Digital Telephones (Criteria A)

**Radio Frequency Emissions:**
Per **89/336/EEC** EMC: **EN 61326: 1998** (Electrical Equipment for measurement,

control and laboratory use—EMC requirements) "Class B" emission limits. Supporting test records by Criterion Technology O.A.T.S. (NVLAP #0369), certified compliance by Hach Company.

**Additional Radio Frequency Emissions Standard(s) include:**
**EN 55022 (CISPR 22),** Class B emissions limits.

**Canadian Interference-causing Equipment Regulation, IECS-003, Class A:** Supporting test records by Criterion Technology, Intellistor O.A.T.S. (NVLAP #0369), certified compliance by Hach Company.

This Class A digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations.

Cet appareil numérique de la classe A respecte toutes les exigences du Règlement sur le matériel brouilleur du Canada.

**FCC Part 15, Class "A" Limits:** Supporting test records by Criterion Technology, Intellistor O.A.T.S. (NVLAP #0369), certified compliance by Hach Company.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

(1) This device may not cause harmful interference, and (2) This device must accept any interference received, including interference that may cause undesired operation.

# CERTIFICATION, continued

Changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at his own expense. The following techniques of reducing the interference problems are applied easily.

1. Remove power from the Pocket Colorimeter instrument by removing one of its batteries to verify that it is or is not the source of the interference.
2. Move the Pocket Colorimeter instrument away from the device receiving the interference.
3. Reposition the receiving antenna for the device receiving the interference.
4. Try combinations of the above.

# SAFETY PRECAUTIONS

Please read this entire manual before unpacking, setting up, or operating this instrument. Pay particular attention to all danger and caution statements. Failure to do so could result in serious injury to the operator or damage to the equipment.

To ensure the protection provided by this equipment is not impaired, do not use or install this equipment in any manner other than that which is specified in this manual.

## Use of Hazard Information

If multiple hazards exist, this manual will use the signal word (Danger, Caution, Note) corresponding to the greatest hazard.

***DANGER***
***Indicates a potentially or imminently hazardous situation which, if not avoided, could result in death or serious injury.***

***CAUTION***
***Indicates a potentially hazardous situation that may result in minor or moderate injury.***

***NOTE***
***Information that requires special emphasis.***

## Precautionary Labels

Please pay particular attention to labels and tags attached to the instrument. Personal injury or damage to the instrument could occur if not observed.

 This symbol, if noted on the instrument, references the instruction manual for operational and/or safety information.

# SPECIFICATIONS

**Lamp:** Light emitting diode (LED)

**Detector:** Silicon cell

**Wavelength:** As specified by model, ± 2 nm

**Instrument repeatability:** 0.01 Abs

**Filter bandwidth:** 15 nm

**Absorbance display range:** 0 to 2.55 Abs

**Linearity:** Varies with model; 1% to 1.00 Abs or greater;
1% to 1.50 Abs typical

**Dimensions:** 3.2 x 6.1 x 15.2 cm (1.25 x 2.4 x 6 inches)

**Weight:** 0.2 kg (0.43 lbs)

**Operating conditions:** 0 to 50 °C; 0 to 90% relative humidity (noncondensing)

**Sample cell pathlength:** 10 and 22.4 mm

**Power supply:** 4 AAA alkaline batteries; approximate life is 750 tests

**Generic Pocket Colorimeter™ Models**

| Pocket Colorimeter Analysis System | Part Number |
|---|---|
| 420 nm Generic | 46777-42 |
| 450 nm Generic | 46777-45 |
| 476 nm Generic | 46777-47 |
| 500 nm Generic | 46777-50 |
| 528 nm Generic | 46777-52 |
| 550 nm Generic | 46777-55 |
| 580 nm Generic | 46777-58 |
| 600 nm Generic | 46777-60 |
| 655 nm Generic | 46777-65 |

See *Table 5* on page *51* to help select a colorimeter with the appropriate wavelength for the sample to be measured.

# OPERATION

### *DANGER*

***Handling chemical samples, standards, and reagents can be dangerous. Review the necessary Material Safety Data Sheets and become familiar with all safety procedures before handling any chemicals.***

### *DANGER*

***La manipulation des échantillons chimiques, étalons et réactifs peut être dangereuse. Lire les Fiches de Données de Sécurité des Produits (FDSP) et se familiariser avec toutes les procédures de sécurité avant de manipuler tous les produits chimiques.***

### *PELIGRO*

***La manipulación de muestras químicas, estándares y reactivos puede ser peligrosa. Revise las fichas de seguridad de materiales y familiarícese con los procedimientos de seguridad antes de manipular productos químicos.***

### *GEFAHR*

***Das Arbeiten mit chemischen Proben, Standards und Reagenzien ist mit Gefahren verbunden. Es wird dem Benutzer dieser Produkte empfohlen, sich vor der Arbeit mit sicheren Verfahrensweisen und dem richtigen Gebrauch der Chemikalien vertraut zu machen und alle entsprechenden Materialsicherheitsdatenblätter aufmerksam zu lesen.***

### *PERIGO*

***A manipulação de amostras, padrões e reagentes químicos pode ser perigosa. Reveja a folha dos dados de segurança do material e familiarize-se com todos os procedimentos de segurança antes de manipular quaisquer produtos químicos.***

# GENERAL DESCRIPTION

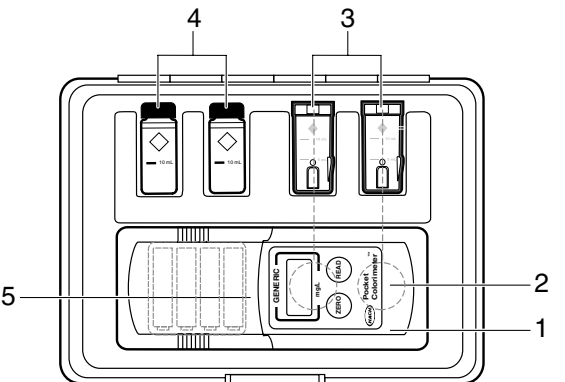
Hach Pocket Colorimeter™ instruments* are low-cost, high-quality filter photometers designed for various types of colorimetric measurements. This generic model displays a direct readout of absorbance or operator-defined values. The instrument has two modes (LO and HI) in which measurements can be made. The HI mode offers a basic absorbance mode or operator-defined units with hundredths resolution (0.00) from 0.00 to 2.55. The LO mode is specifically designed to handle operator-defined units with tenths resolution (0.0) from 0.0 to 99.0. The operator-entered calibration(s) will remain in memory until the operator performs a series of keystrokes to restore the factory settings.

Power is supplied by four AAA alkaline batteries. A set of batteries provides approximately 750 tests because of battery-saving features incorporated into the software. The instrument automatically shuts off if no keystrokes are made for 1 minute when in the measurement mode or 10 minutes when in the calibration mode. The colorimeter lamp is an LED (light emitting diode) and is on only long enough for the measurement to take place (approximately 2 seconds).

The instrument comes with two 10-mL sample cells, two 1-cm/10-mL sample cells, four AAA batteries, and this instruction manual contained in a 22 x 18 x 15 cm (9 x 7 x 6 inch) polypropylene case. See *Figure 1*. The case includes room for powder pillow reagents.

* U.S. patents 5,083,868 and D333,992.

**Figure 1 Packaging Guide**




| | | |
|---|---|---|
| **1.** | Pocket Colorimeter™ Instrument, Generic | 46777-xx |
| **2.** | Cap, Sample Cell, 1-cm/10-mL (under instrument) | 52626-00 |
| **3.** | Sample Cells, 1-cm/10-mL | 41658-02 |
| **4.** | Sample Cells, 10 mL | 24276-06 |
| **5.** | Batteries, alkaline AAA, 1.5 V, 4/pkg | 46743-00 |

## Safety Precautions

As part of good laboratory practice, please become familiar with any reagents used. Read all product labels and the material safety data sheets (MSDS) before using chemicals. It is always good practice to wear safety glasses when handling chemicals. Follow instructions carefully. Rinse thoroughly if contact occurs. If there are any questions about reagents or procedures, please contact Hach Company.

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.

To ensure the protection provided by this equipment is not impaired, this equipment MUST NOT be installed or used in any manner other than that which is specified in this manual.

### Use of Hazard Information

If multiple hazards exist, the signal word corresponding to the greatest hazard shall be used.

***DANGER***
***Indicates a potentially or imminently hazardous situation which, if not avoided, could result in death or serious injury.***

***CAUTION***
***Indicates a potentially hazardous situation that may result in minor or moderate injury.***

***NOTE***
***Information that requires special emphasis.***

## Cleaning the Instrument

To clean the Pocket Colorimeter instrument, use a damp cloth to wipe surfaces. Do not submerge the instrument.

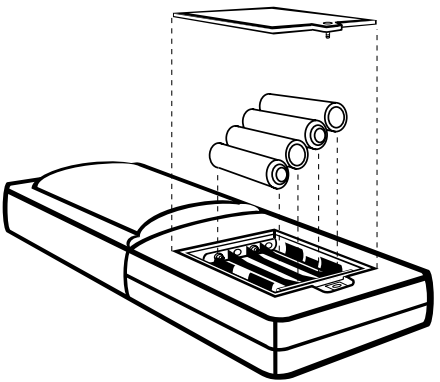
## Battery Installation

*Figure 2* provides an exploded view of battery installation. Loosen the captive screw and remove the battery compartment cover. The proper polarities are shown on the battery holder. Place the four batteries provided with the instrument in the holder as indicated and replace the battery compartment cover. The display will show the

software version number (e.g., **P 1.6**) after correct battery installation. When replacing discharged batteries, always replace the complete set of four.

***Note:*** *Only alkaline batteries may be used in this instrument.* ***Rechargeable batteries are not recommended*** *and cannot be recharged in the instrument.*

**Figure 2 Battery Installation**



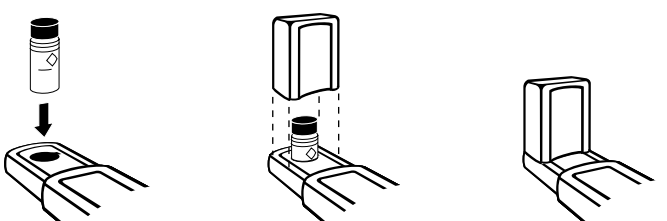
## Sample Cell Insertion

Place a 10-mL sample cell into the cell compartment with the diamond mark facing the keypad.

Use the instrument cap as a light shield during measurements. Orient the cap's curved surface toward the keypad. This position will allow the cap to match the grooves in the instrument case to provide a good seal against stray light. See *Figure 3*.

For consistent and accurate results, clean and dry the outside of sample cells before inserting them into the Pocket Colorimeter instrument.

**Figure 3 Sample Cell Insertion**



## Modes of Operation

In colorimetric tests, the color of the sample, or color loss, is proportional to the concentration or amount of the parameter being measured. In some cases, a reagent is added to the sample which reacts with the desired analyte to produce the color or color loss. In other cases, the analyte has an inherent color that can be measured directly. Occasionally, colorimeters also are used to measure the change in light transmission through a mixture due to particles in the liquid (turbidity). The Pocket Colorimeter instrument has three modes of quantitative measurement.

1. Basic Absorbance Mode (HI default mode)—Use to measure the absorbance (Abs) of a sample at the wavelength specified for the colorimeter. Concentration values can be manually determined from a calibration curve. Use this mode for linear or non-linear calibration curves.
2. Operator-Entered Calibration (LO mode)—Use for operator-entered calibrations for direct concentration readout with readings between 0.0 and 99.0. The calibration curve must be linear. The value of the calibration standard can be any value between 1.0 and 99.0.

3. Operator-Entered Calibration (HI mode)—Use for operator-entered calibrations for direct concentration readout with readings between 0.00 and 2.55. The calibration curve must be linear. The value of the calibration standard can be any value between 0.10 and 2.55.

***Note:*** *Once the HI mode has been operator-calibrated, the default factory settings must be restored before using the Basic Absorbance Mode. Restoring the factory setting erases the operator-entered calibration.*

***Note:*** *The 10-mL (22.4-mm pathlength) and 1-cm/10-mL (1 cm path length) cells can be used in the Pocket Colorimeter instrument. In general, the 10-mL cells will provide better accuracy, precision, and resolution, but narrower ranges. The smaller, 10-mm cells can be used to extend the working range, but usually with poorer accuracy and precision.*

***Note:*** *Absorbance calibration curves depend on the instrument bandwidth, detector, and other factors. Pocket Colorimeter instruments of the same model will have similar absorbance calibration curves. However, other instruments may have significantly different calibration curves.*

### Changing Instrument Modes

The mode currently in use on the colorimeter can be determined by the display. If the display shows tenths, the colorimeter is in the LO mode. If the display shows hundreths, the HI mode is in use. If an operator-entered calibration is used for the HI

mode, the instrument display does not indicate whether it or the default absorbance mode is in use.

To change modes, press the **ZERO** and **READ** keys simultaneously. After 1 second, release the **ZERO** key and continue holding down the **READ** key until **LO** or **HI** appears in the display. Release the **READ** key after **LO** or **HI** appears in the display. Repeat to change the mode back to the previously displayed mode. The instrument will then operate in the indicated mode.

## Absorbance Calibration Curve

Test a series of samples with known concentrations (standards) using the Pocket Colorimeter instrument in the default absorbance mode. Plot the measured absorbances and corresponding concentrations for each standard on a graph of concentration vs. absorbance. The plotted data points will form a straight line or a curve. This line or curve is referred to as the "calibration curve." See *Table 1* on page *27* and *Figure 4* on page *28* for a calibration curve example. Additional examples are on pages *36* and *38*.

The calibration curve is used to determine the concentration of unknown samples. The point on the calibration curve where the absorbance of an unknown intersects the curve corresponds to the concentration of the unknown sample. Prepare the calibration curve using the following guidelines:

1. Make sure the instrument is in the default HI mode. See *Changing Instrument Modes* on page *22* and *Retrieving the Basic Absorbance Mode* on page *35*.
2. Prepare standard solutions covering the expected concentration range of the unknown samples. A series of dilutions of the highest standard concentration is a

convenient technique to obtain various concentrations. Use at least five different concentrations for best results.

3. Add reagents, if necessary, mix, and allow necessary time for full color development.

4. Zero the instrument on the appropriate blank solution (water, reagent in pure water, etc.).

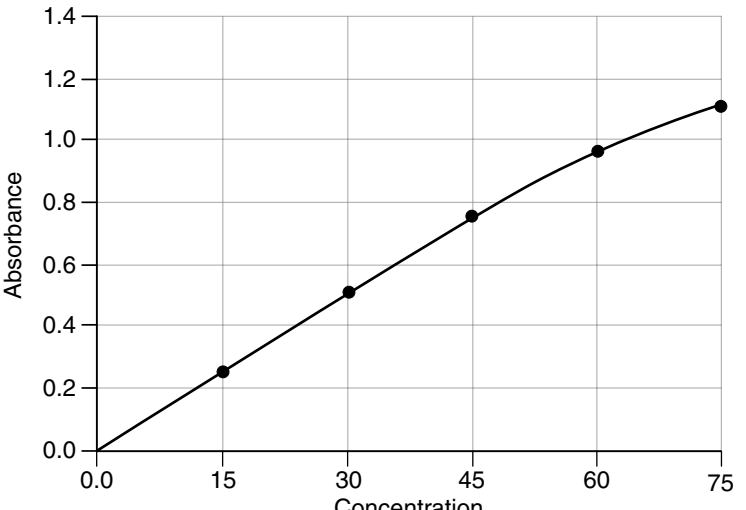
***Note:*** *The blank solution used to zero the instrument should be identical to the standard solution in composition without the colored analyte. If reagents are used to develop a color and the reagent blank is significant compared to untreated samples or pure water, best results may be obtained by zeroing the instrument on a reagent blank. When measuring unknowns using untreated samples for the blank, either subtract the reagent blank value from readings or use the reagent blank to zero the instrument before making measurements.*

5. Read the absorbance (Abs) of each prepared standard. See *Table 1*.

**Table 1 Example of Calibration Data**

| Concentration | Abs | Concentration | Abs |
|---|---|---|---|
| 0.0 | 0.00 | 45.0 | 0.76 |
| 15.0 | 0.26 | 60.0 | 0.96 |
| 30.0 | 0.52 | 75.0 | 1.12 |

**Figure 4** **Example of Non-Linear Calibration Curve (from *Table 1*)**



6. Prepare a graph with concentration on the horizontal axis and absorbance on the vertical axis. The range of concentrations and absorbances on the axes should approximate the range of concentrations used and the range of absorbances measured. See *Figure 4* on page *28*.

7. Plot the points on the graph where the known concentrations and corresponding measured absorbances intersect. Draw a line or sketch a curve through the data points. Do not simply "connect the dots," but draw a straight line or smooth curve through the data points while balancing the points on either side of the line or curve. This line or curve is then considered the "best fit" of the data points. The calibration curve should ideally intersect the 0 absorbance, 0 concentration intercept. Alternatively, use a software program with graphing capabilities to construct the calibration curve.

***Note:*** *If the data points plot as a straight line, performing an operator-entered calibration with the LO or HI mode will allow the operator to determine the concentration of unknowns from the instrument display directly rather than from the calibration curve.*

## Operator-Entered Calibrations—Linear Chemistries Only

Switch the Pocket Colorimeter instrument to the appropriate mode (see *Changing Instrument Modes* on page *22*). The LO mode will accommodate sample concentrations up to 99.0 operator-defined units. The HI mode offers hundredths resolution up to 2.55 operator-defined units.

Calibrate the instrument with two points: the blank or zero value sample, and the concentration representing the largest sample concentration expected. Follow the instructions in the *Operator-Entered Calibration—Non-bleaching Chemistries* section below.

## Operator-Entered Calibration—Non-bleaching Chemistries

1. Turn the instrument on.
2. Press the **ZERO** and **READ** keys simultaneously and hold them down for several seconds. The display will show **CAL**, then a flashing **0**.
3. Insert the sample cell containing the blank solution into the cell holder (if using the 10-mL cells, face the diamond mark toward the keypad). Cover the sample cell with the instrument cap, making sure the cap fits tightly against the instrument.

4. Press the **ZERO** key. The instrument will display **- - -** followed by **1.0** (LO mode) or **0.10** (HI mode) with the decimal flashing.

5. Press the **ZERO** or **READ** key to change (by scrolling) the displayed value until it matches the standard concentration that you are going to use. If you scroll past the desired value, continue scrolling—the display will "wrap around" to the initial value.

***Note:*** *The* **READ** *key will increase the display by the smallest digit (furthest to the right) while the* **ZERO** *key will increase the display by the second smallest digit (second from the right).*

6. When the desired value is displayed, press the **ZERO** and **READ** keys simultaneously and hold them until **Std** appears in the display.

7. Insert the colored standard solution into the cell holder. Cover the cell with the instrument cap.

8. Press the **READ** key. The instrument will compute the calibration and display the value entered for the standard. The calibration is complete.

The instrument will use this calibration to determine the concentration in subsequent tests.

Refer to *Table 2* for a summary of the calibration steps.

To exit the calibration routine early or to return to the factory calibration, follow the instructions outlined in *Exiting the Calibration Routine* on page *35.*

**Table 2 Calibration Quick Reference**

| Step | Action/Keystroke | Display |
|---|---|---|
| **1.** Select desired range mode | **ZERO** and **READ,** hold **READ** | **HI** or **LO** |
| **2.** Select calibration mode | **ZERO** and **READ** | **CAL**, then flashing **0** |
| **3.** Place blank into cell holder | **ZERO** | **- - -**, then **1.0** (LO mode) or **- - -**, then **0.10** (HI mode) |
| **4.** Scroll to desired concentration value | **ZERO** or **READ** | Value assigned |
| **5.** Lock in concentration value | **ZERO** and **READ** | **Std** |
| **6.** Place standard in cell holder | **READ** | Shows value assigned in steps 4 and 5 |

## Operator-Entered Calibration—Bleaching Chemistries

Use the following steps to calibrate the Pocket Colorimeter instrument for chemistries in which the samples are less colored than the blank. The instrument cannot give readings when the sample is less colored than the blank when operated as previously instructed. The following steps reverse the usual relationship between the blank and sample to permit obtaining a reading.

1. Turn the instrument on. Verify it is in the correct mode, HI or LO.
2. Press the **ZERO** and **READ** keys simultaneously and hold them down for several seconds. The display will show **CAL**, then a flashing **0**.
3. Insert the sample cell containing the reacted calibration standard solution into the cell holder (if using a 10-mL cell, face the diamond mark toward the keypad). Cover the sample cell with the instrument cap, making sure the cap fits tightly against the instrument.
4. Press the **ZERO** key. The instrument will display **- - -** followed by **1.0** (LO mode) or **0.10** (HI mode) with the decimal flashing.

5. Press the **ZERO** or **READ** key to change (by scrolling) the displayed value until it matches the standard concentration. If you scroll past the desired value, continue scrolling—the display will "wrap around" to the initial value.

***Note:*** *The* **READ** *key will increase the display by the smallest digit (furthest to the right) while the* **ZERO** *key will increase the display by the second smallest digit (second from the right).*

6. When the desired value is displayed, press the **ZERO** and **READ** keys simultaneously and hold them until **Std** appears in the display.

7. Insert the blank solution (more colored than the standard solution) into the cell holder. Cover the cell with the instrument cap.

8. Press the **READ** key. The instrument will compute the calibration and display the value entered for the standard. The calibration is complete.

The instrument will use this calibration to determine the concentration of future samples.

When testing samples from a bleaching chemistry, insert the sample and press **ZERO**. Then insert the blank and press **READ**. The instrument must be zeroed on each sample and the blank re-read.

## Exiting the Calibration Routine

When the display flashes **0** or when **Std** appears in the display, exit the calibration routine by pressing the **ZERO** and **READ** keys simultaneously and holding them for 2 seconds. The instrument exits to normal mode and **ESC** appears and remains displayed until **ZERO** or **READ** is pressed (this also performs the function of the pressed key) or until automatic shut-off occurs. The instrument will then use the last completed operator-entered calibration or return to the factory settings if an operator-entered calibration was not in use.

## Retrieving the Basic Absorbance Mode

Once the HI mode has been operator-calibrated, the default settings must be retrieved before absorbance readings can be collected. To retrieve the Basic Absorbance Mode:

1. Press the **ZERO** and **READ** keys simultaneously and hold them for several seconds. **CAL** will appear in the display, followed by a flashing **0**.
2. While the display is flashing, press and hold the **READ** key for several seconds. The display will show **dFL** (signifying default) and the calibration mode is exited. **dFL** is displayed until the **ZERO** or **READ** key is pressed (which also performs the function of the pressed key) or until automatic shut-off occurs. Once the absorbance mode is restored, any HI mode operator-entered calibration is erased.

## Calibration Examples

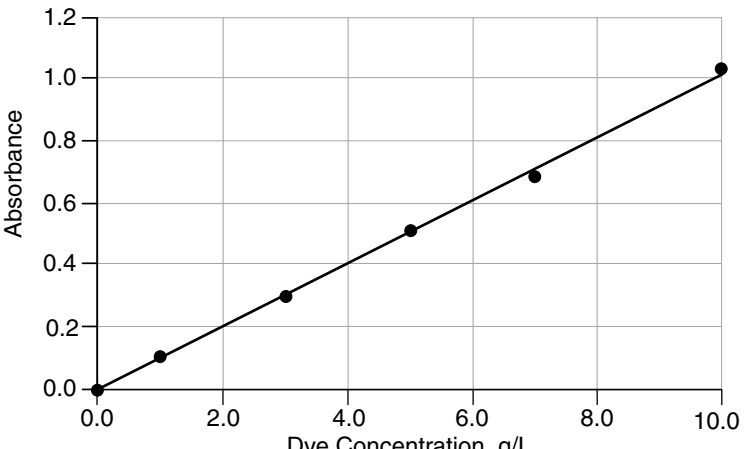
**Example 1**

A food dye manufacturer wants to quickly check a liquid product's red dye concentration with a 528-nm Generic Pocket Colorimeter instrument. Five standard solutions are prepared ranging from 1 g/L to 10 g/L. Using the default HI mode, which gives readout as Abs, the instrument is zeroed on water in a 10-mL sample cell. Each of the standards is read by the instrument (see *Table 3*).

**Table 3 Example 1**

| Dye Conc, g/L | Abs |
|---|---|
| 0.0 | 0.00 |
| 1.0 | 0.11 |
| 3.0 | 0.30 |
| 5.0 | 0.52 |
| 7.0 | 0.68 |
| 10.0 | 1.03 |

**Figure 5 Example 1: Calibration Curve**



The data points are then plotted on graph paper. The x-axis (horizontal) is used to plot the concentration of the dye. The y-axis (vertical) is used to plot the instrument absorbance. See *Figure 5*.

A good linear relationship is observed. The operator now decides to use the LO mode and performs a simple operator calibration using water (blank) and the 10.0 g/L dye solution. The intermediate standards are then re-read to verify accuracy. The instrument is now ready to determine dye concentrations in unknown samples using the LO mode.

**Example 2**

A reagent reacts with iron in a water sample to give a blue color. A 580-nm Generic Pocket Colorimeter instrument is to be used to measure the level of iron in unknown samples. The largest iron concentration expected is 2.00 mg/L Fe. Eight standard solutions from 0.00 to 2.00 mg/L Fe are prepared.

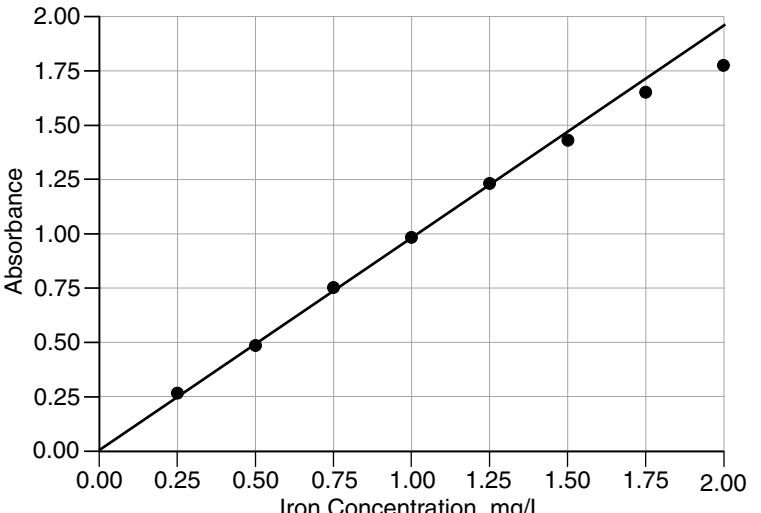
The instrument is zeroed on a “reagent blank” where reagent is added to a water sample that is free of iron. Each standard, in turn, is then mixed with reagent, allowed

to develop full color, and read in the Pocket Colorimeter instrument to measure the absorbance (see *Table 4*).

**Table 4 Example 2**

| Iron Conc, mg/L | Abs |
|---|---|
| 0.00 | 0.00 |
| 0.25 | 0.26 |
| 0.50 | 0.49 |
| 0.75 | 0.75 |
| 1.00 | 0.99 |
| 1.25 | 1.24 |
| 1.50 | 1.45 |
| 1.75 | 1.65 |
| 2.00 | 1.76 |

**Figure 6 Example 2: Calibration Curve**



The data points are plotted on graph paper as in *Figure 6*. Notice the data is linear up through 1.25 mg/L Fe, but then starts to curve. The graph must be used to find sample concentrations from instrument absorbance values for concentrations above 1.25 mg/L Fe.

The HI mode, however, can be operator-calibrated on a 1.25 mg/L Fe standard, since the Concentration/Absorbance relationship is linear up through 1.25 mg/L. Dilute and re-measure samples with readings above 1.25 mg/L to stay within the working range of the calibration curve. The Pocket Colorimeter instrument will not indicate when displayed values are beyond the linear range of the test. See page *47* and page *54* for additional information about calibration curves.

# ERROR MESSAGE DISPLAY

When the instrument cannot perform the function initiated by the operator, an error message appears in the display. Refer to the appropriate message information below to identify the problem and how to correct it. Resolve error messages in the order they appear on the display. Hach Service Centers are listed on page *61*.

## Error Messages

1. **E-1–Unstable Reading**
   - Verify instrument cap is correctly seated.
   - Check for light blockage.
   - Verify LED lights up when a key is pressed.
   - Contact a Hach Service Center.
2. **E-2–Low Light Error**
   - Check for light blockage.
   - Verify LED lights up when a key is pressed.
   - Contact a Hach Service Center.

3. **E-3–Low Battery Message**
   - Verify batteries are installed properly.
   - Replace batteries.
   - Contact a Hach Service Center.
4. **E-4–EEPROM failure**
   - Verify low battery message (E-3) is not displayed before E-4.
   - Contact a Hach Service Center.
5. **E-5–EEPROM failure on zeroing function**
   - Verify low battery message (E-3) is not displayed before E-5.
   - Contact a Hach Service Center.
6. **E-6–EEPROM failure on calibration**
   - Verify low battery message (E-3) is not displayed before E-6.
   - Contact a Hach Service Center.

**7. E-7–Improper calibration**

- Verify instrument cap is correctly seated.
- Check for light blockage.
- Verify LED lights when a key is pressed.
- Contact a Hach Service Center.

**8. Flashing 0.00 or 0.0 (underrange)**

- Verify instrument cap is correctly seated.
- Check zero by reading a blank. If error recurs, re-zero the instrument.
- Contact a Hach Service Center.

**9. Flashing 2.55 or 99.0 (overrange)**

- Dilute and re-measure the sample.
- Check for light blockage.

# APPENDIX A - Basic Colorimetry

Colorimetry is a method of measurement that relates the amount of color in a transparent medium, such as a liquid, to the amount of a particular substance in the liquid. In general, the concentration of the substance being measured is proportional to the intensity of the color in the solution. The darker the color, the higher the concentration. Absorbance (Abs) is a commonly used measure of the amount of light absorbed by the solution. Absorbance is given by:

$Abs = -\log T$ or $Abs = -\log (I_T/I_O)$

Where:

T = Transmittance

$I_T$ = Intensity of light transmitted through the sample

$I_O$ = Intensity of light entering the sample

Some substances, such as dyes and various metals, are already colored and can be measured directly. Other compounds require a chemical reaction in which an indicator reacts with the substance, resulting in a colored product that can be measured. The majority of Hach chemistries are of this variety.

After the relationship between the amount of color (measured as absorbance) and a sample's concentration is determined, the instrument can be easily used to measure concentrations of unknown samples. While most Hach colorimeters and spectrophotometers already have these relationships preprogrammed, Generic Pocket Colorimeter™ instruments require the operator to use a calibration curve or to manually program the Pocket Colorimeter instrument to measure sample concentration.

The amount of color in a sample is determined by measuring the amount of light the solution will absorb. The absorption of light depends on the wavelength of the light and the color of the solution. Because the light source in a Pocket Colorimeter instrument is an LED that emits a narrow range of wavelengths and an interference filter is used to further narrow the wavelength range, only samples with certain colors can be measured by any one instrument. The analysis of different colored solutions requires the use of different Pocket Colorimeter instruments, which utilize different LEDs and filters. Hach offers a variety of Generic Pocket Colorimeter instruments with various wavelengths to accommodate most sample colors. See *Generic Pocket Colorimeter™ Models* on page *12*.

The wavelength (color) of light used is normally selected so that it has a maximum absorption but may vary to minimize interferences or other factors. Ideally, the instrument wavelength is selected based on knowledge about the absorbance spectra of the species of interest, as well as the spectra of other colored species which might be present in the sample. *Figure 7* illustrates a typical absorption spectrum. *Table 5* on page 51 can be used as a starting point for selecting the appropriate instrument wavelengths for use in testing. This table will not be useful for samples that have more than one absorption spectra that contribute to the color seen by the eye. For example, a green solution can have a yellow and a blue absorption peak; either peak can be used for measurements. Other samples may appear brown due to several contributing spectra.

**Figure 7** **Selecting the Best Wavelength, Sample Spectrum**

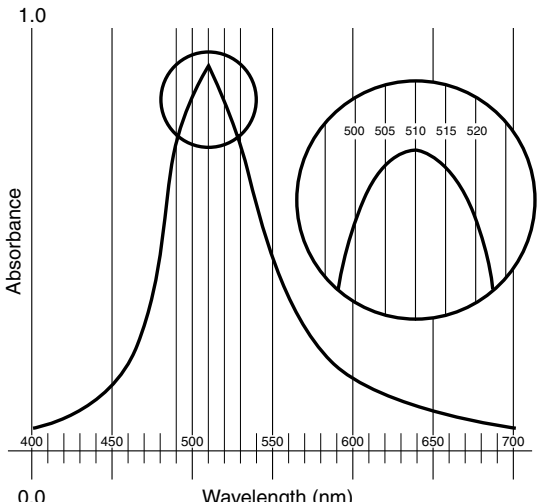


**Table 5 Light Wavelength and Color**

| Color of Solution* | Color of Light Absorbed | Instrument Wavelength |
|---|---|---|
| yellow-green | violet | 420 nm |
| yellow | violet-blue | 450 nm |
| orange | blue | 476 nm |
| orange-red | blue-green | 500 nm |
| red | green | 528 nm |
| red-violet | yellow-green | 550 nm |
| blue | yellow | 580 nm |
| greenish-blue | orange | 600 nm |
| bluish-green | red | 655 nm |

* Color perceived will vary with absorption spectrum of solution.

The working range of the Pocket Colorimeter instrument is typically 0 to 1.50 Abs, but varies from 1.00 to over 2.00 Abs. Absorbance increases with increasing sample cell pathlength. The pathlength is the distance the light travels through the sample,

which is the internal dimension of the cell. If sample absorbances are greater than 1.50, dilute the sample or use smaller sample cells for the best linearity and accuracy. If a smaller sample cell, such as the 1-cm cell is used, the calibration should be completed using these cells. Determine the working range for a specific test by observing the calibration curve. The working range is the concentration range in which the deviation from linearity is within acceptable limits. See *Example 2* on page *38*.

Calibration curves should ideally intersect the 0 absorbance, 0 concentration point on the calibration graph. This means that if there is no analyte present in the sample, no absorbance should be measured by the instrument. A non-zero intercept, where no analyte is present in the sample but a positive or negative absorbance is still measured, may occur for several reasons. Factors such as reagent blank, pH, temperature, interfering species, or turbidity differences between the zeroing solution and the sample can cause non-zero intercepts, especially in tests where reagents are used.

A reagent blank is the amount of color that is contributed solely by the reagent and not the analyte. In an aqueous sample, the reagent blank is prepared by adding reagents to deionized water. Subtracting a reagent blank value from all measured absorbances can bring the calibration curve closer to the ideal zero intercept.

Some chemistries may be used where the loss of color upon the addition of a reagent determines the concentration of the sample. Such chemistries are referred to as bleaching chemistries because the measured sample is lighter than the solution used to zero the instrument. The Generic Pocket Colorimeter instrument cannot be programmed to measure a sample that is lighter than the zeroing solution. In order to use such chemistries, first zero the instrument on the sample, then read the blank. (See *Operator-Entered Calibration—Bleaching Chemistries* on page *33*.)

Alternatively, use the absorbance mode and zero the instrument on a clear solution such as deionized water, measure both the blank solution and sample, and subtract the blank reading from the sample reading. Plot the difference in absorbance readings vs. concentration to manually determine concentration.

# APPENDIX B - Good Analytical Techniques

Use operator-entered calibrations only when the Concentration/Absorbance relationship is linear. When a calibration has been programmed into the Pocket Colorimeter™ instrument, the instrument assumes that the entire programmable range (0 to 2.55 for the HI range and 0 to 99.0 for the LO range) is linear. Values above the working range of the calibration curve may be displayed and may be erroneous. For example, if the working range for a test is from 0 to 50.0 mg/L and a sample measures 65.0 mg/L, the result may be incorrect because it is above the working range of the test. Question displayed results above the working range of the test and if necessary, make a dilution or repeat the calibration using a shorter pathlength sample cell to remain within the working range of the test.

Calibrate with a standard concentration that is higher than all expected sample concentrations to minimize measurement errors. This simple two-point calibration curve may not give the same results as would be obtained from a “best-fit” calibration curve. Verify calibration curves are linear by testing several standards before entering an operator-entered calibration.

Always test to see if an operator-entered calibration is working properly. Re-read the calibration standard concentration, in addition to testing intermediate concentrations.

The instrument does not visually distingush between the use of the default factory settings or the operator-entered calibration in the LO mode. If different operators use the instrument, develop a means of tracking any calibration changes. If it is not known whether the operator-entered calibration is in use, test a calibration standard or repeat the calibration.

Sample cells must be clean and free of scratches where the light passes through them. Ensure that there are no fingerprints or liquid on the outsides of the cells.

# REPLACEMENT PARTS

| Description | Unit | Cat No. |
|---|---|---|
| Batteries, alkaline, AAA, 1.5 V | 4/pkg | 46743-00 |
| Instrument Cap/Light Shield | each | 46704-00 |
| Instrument Manual | each | 49732-88 |
| Sample Cells, 10-mL, with caps | 6/pkg | 24276-06 |
| Sample Cells, 1-cm/10-mL | 2/pkg | 41658-02 |
| Sample Cell Caps | each | 52626-00 |

# GENERAL INFORMATION

**At Hach Company, customer service is an important part of every product we make.**

**With that in mind, we have compiled the following information for your convenience.**

# HOW TO ORDER

**By Telephone:**
6:30 a.m. to 5:00 p.m. MST
Monday through Friday
(800) 227-HACH (800-227-4224)

**By FAX:**
(970) 669-2932 (Hach Loveland)

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

**For order information by E-mail:**
orders@hach.com

**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

**Technical and Customer Service (USA only)**
Hach Technical and Customer Service Department personnel are eager to answer questions about our products and their use and to take your orders. Specialists in analytical methods, they are happy to put their talents to work for you.
Call **1-800-227-4224** or E-mail **techhelp@hach.com**.

## International Customers

Hach maintains a worldwide network of dealers and distributors. To locate the representative nearest you, send E-mail to **intl@hach. com** or call (970) 669-3050.

## In Canada

Hach Sales & Service Canada Ltd., Manitoba, Canada
Telephone: (204) 632-5589; FAX: (204) 694-5134

# REPAIR SERVICE

Authorization must be obtained from Hach Company before sending any items for repair. Please contact the Hach Service Center serving your location.

**In the United States:**
Hach Company
100 Dayton Avenue
Ames, Iowa 50010
(800) 227-4224 (USA only)
FAX: (515) 232-3835

**Canada:**
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1313 Border Street, Unit 34
Winnipeg, Manitoba R3H 0X4
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Telephone: +49/[0]211.52.88.0
FAX: +49/[0]211.52.88.231

# WARRANTY

Hach warrants most products against defective materials or workmanship for two years from the date of shipment.

**HACH WARRANTS TO THE ORIGINAL BUYER THAT HACH PRODUCTS WILL CONFORM TO ANY EXPRESS WRITTEN WARRANTY GIVEN BY HACH TO THE BUYER. EXCEPT AS EXPRESSLY SET FORTH IN THE PRECEDING SENTENCE, HACH MAKES NO WARRANTY OF ANY KIND WHATSOEVER WITH RESPECT TO ANY PRODUCTS. HACH EXPRESSLY DISCLAIMS ANY WARRANTIES IMPLIED BY LAW, INCLUDING BUT NOT LIMITED TO ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.**

**LIMITATION OF REMEDIES:** Hach shall, at its option, replace or repair nonconforming products or refund all amounts paid by the buyer. **THIS IS THE EXCLUSIVE REMEDY FOR ANY BREACH OF WARRANTY.**

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Catalog descriptions, pictures and specifications, although accurate to the best of our knowledge, are not a guarantee or warranty.

For a complete description of Hach Company's warranty policy, request a copy of our Terms and Conditions of Sale for U.S. Sales from our Customer Service Department.

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