

Carmine Method¹

0.2 to 14.0 mg/L B

Method 8015

Powder Pillows

Scope and application: For water and wastewater.¹ Adapted from *Standard Methods for the Examination of Water and Wastewater*.**Test preparation****Instrument-specific information**

[Table 1](#) shows all of the instruments that have the program for this test. The table also shows sample cell and orientation requirements for specific instruments.

To use the table, select an instrument, then read across to find the applicable information for this test.

Table 1 Instrument-specific information

Instrument	Sample cell orientation	Sample cell
DR 6000 DR 3800 DR 2800 DR 2700 DR 1900	The fill line is to the right.	2495402 
DR 5000 DR 3900	The fill line is toward the user.	

Before starting

Make sure that all labware is dry. Excess water causes low results.

Use the BoroVer 3 Reagent in a fume hood or with sufficient airflow. Refer to [Reagent preparation](#) on page 3 for more information.

Do not put a cap on the sample cells or the Erlenmeyer flasks during the sample preparation or reaction time. A cap can be put on the sample cells immediately before insertion into the instrument.

Sulfuric acid can contain residual moisture, which causes low results. Complete the test procedure with a known boron standard solution to make sure that the sulfuric acid is good.

Review the Safety Data Sheets (MSDS/SDS) for the chemicals that are used. Use the recommended personal protective equipment.

Dispose of reacted solutions according to local, state and federal regulations. Refer to the Safety Data Sheets for disposal information for unused reagents. Refer to the environmental, health and safety staff for your facility and/or local regulatory agencies for further disposal information.

Items to collect

Description	Quantity
BoroVer 3 Boron Reagent Powder Pillow	1
Sulfuric Acid, concentrated, ACS	75 mL
Water, deionized	2 mL
Cylinder, graduated, 100-mL	1
Cylinder, graduated, 50-mL	1

Items to collect (continued)

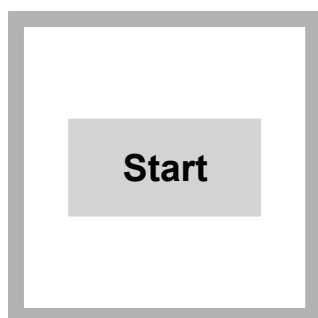
Description	Quantity
Flask, Erlenmeyer, 250-mL	1
Flask, Erlenmeyer, 125-mL	2
Pipet, volumetric, Class A, 2.0-mL	2
Pipet filler, safety bulb	1
Sample cells (For information about sample cells, adapters or light shields, refer to Instrument-specific information on page 1.)	2

Refer to [Consumables and replacement items](#) on page 5 for order information.

Sample collection

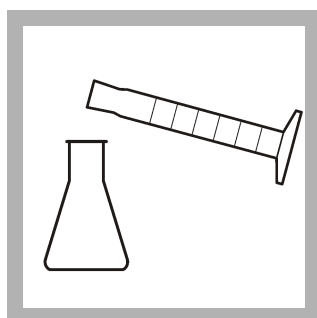
Collect samples in clean polyethylene or polypropylene bottles.

Powder pillow procedure

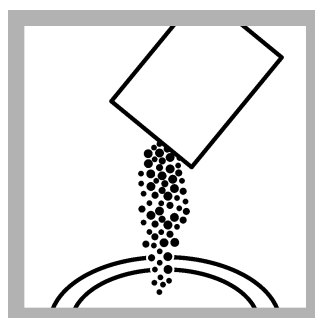


1. Start program 40 Boron. For information about sample cells, adapters or light shields, refer to [Instrument-specific information](#) on page 1.

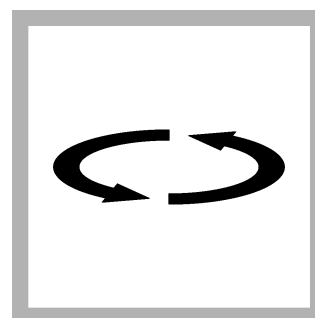
Note: Although the program name can be different between instruments, the program number does not change.



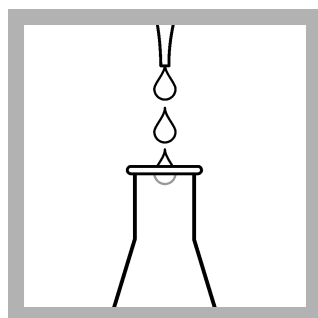
2. Use a 100-mL graduated cylinder to measure 75 mL of concentrated sulfuric acid. Pour the acid into a 250-mL Erlenmeyer flask.



3. In a well-ventilated area or fume hood, add the contents of one BoroVer 3 Reagent Powder Pillow to the flask.



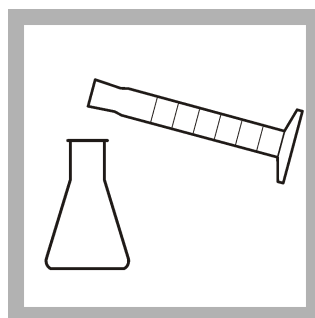
4. Swirl to mix. Wait for up to 5 minutes for the powder to completely dissolve.



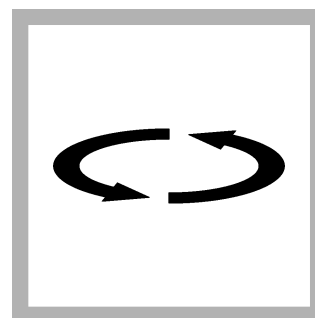
5. Prepare the blank: Use a pipet to add 2.0 mL of deionized water into a 125-mL Erlenmeyer flask.



6. Prepare the sample: Use a pipet to add 2.0 mL of sample into a second 125-mL Erlenmeyer flask.



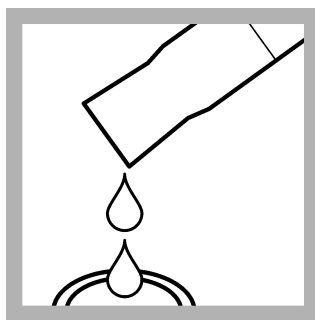
7. Use a 50-mL graduated cylinder to measure 35 mL of the solution prepared in step 3 to each Erlenmeyer flask.



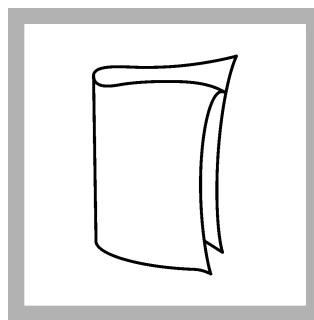
8. Swirl to mix.



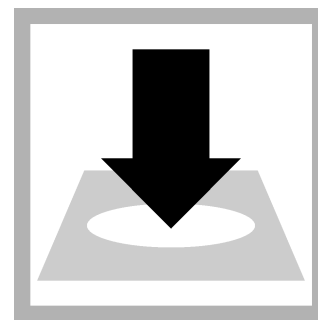
9. Start the instrument timer. A 25-minute reaction time starts.



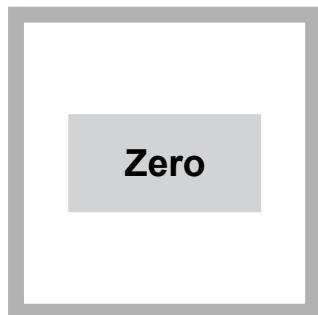
10. When the timer expires, pour at least 10 mL from each flask into separate sample cells.



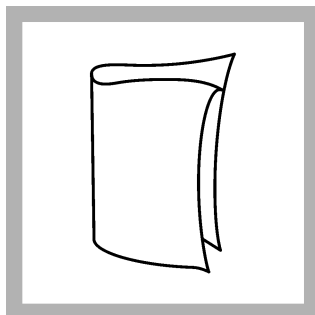
11. Clean the blank sample cell.



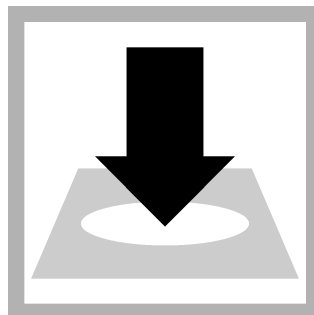
12. Insert the blank into the cell holder.



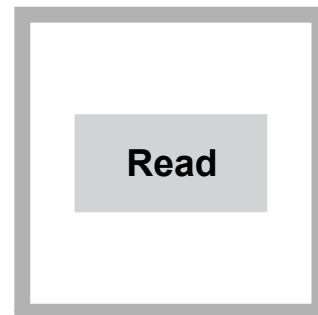
13. Push **ZERO**. The display shows 0.0 mg/L B.



14. Clean the prepared sample cell.



15. Insert the prepared sample into the cell holder.



16. Push **READ**. Results show in mg/L B.

Reagent preparation

More than 75 mL of the BoroVer 3/Sulfuric Acid Solution can be prepared for use in multiple analyses.

Preparation notes

- Gaseous hydrochloric acid (HCl) forms when the powder pillow is added to sulfuric acid. Always mix under a fume hood.
- The solution is stable for a maximum of 48 hours when kept in plastic containers.
- To prevent boron contamination from the glassware, do not keep the solution in borosilicate glassware (Pyrex[®] or Kimax[®]) for more than 1 hour.
- The BoroVer 3/Sulfuric Acid Solution is highly acidic. Refer to the current MSDS/SDS for safe handling and disposal instructions.

1. Determine the amount of sulfuric acid and powder pillows that are necessary for the number of samples to be analyzed. Use 75 mL of sulfuric acid for each analysis. Use one BoroVer 3 Reagent Powder Pillow for each 75 mL of sulfuric acid.
2. Under a fume hood, measure the concentrated sulfuric acid with a graduated cylinder.
3. Pour the acid into a Erlenmeyer flask.
4. Stir the acid and add the contents of one BoroVer 3 Reagent Powder Pillow to the flask. Swirl to mix. Wait for the powder to completely dissolve. Continue to add one powder pillow at a time. Stir to dissolve after each powder pillow is added.
5. Pour this solution into plastic containers and use within 48 hours.

Accuracy check

Standard additions method (sample spike)

Use the standard additions method (for applicable instruments) to validate the test procedure, reagents and instrument and to find if there is an interference in the sample.

Items to collect:

- 1000-mg/L Boron Standard Solution
 - Cylinder, graduated mixing, 25-mL
 - 5-mL and 15-mL volumetric pipets, Class A and pipet filler
 - Deionized water
 - Pipet, TenSette®, 0.1–1.0 mL and tips
1. Prepare a 250-mg/L boron standard solution as follows:
 - a. Use a pipet to add 5.00 mL of a 1000-mg/L boron standard solution into a 25-mL mixing cylinder.
 - b. Dilute to the 20-mL mark with deionized water. Use a 15-mL volumetric pipet to add the deionized water to the cylinder.. Mix well. Prepare this solution daily.
 2. Use the test procedure to measure the concentration of the sample, then keep the (unspiked) sample in the instrument.
 3. Go to the Standard Additions option in the instrument menu.
 4. Select the values for standard concentration, sample volume and spike volumes.
 5. Prepare three spiked samples: use the TenSette pipet to add 0.1 mL, 0.2 mL and 0.3 mL of the prepared standard solution, respectively, to three 25-mL portions of fresh sample. Mix well.
 6. Use the test procedure to measure the concentration of each of the spiked samples. Start with the smallest sample spike. Measure each of the spiked samples in the instrument.
 7. Select **Graph** to compare the expected results to the actual results.

***Note:** If the actual results are significantly different from the expected results, make sure that the sample volumes and sample spikes are measured accurately. The sample volumes and sample spikes that are used should agree with the selections in the standard additions menu. If the results are not within acceptable limits, the sample may contain an interference.*

Standard solution method

Use the standard solution method to validate the test procedure, the reagents and the instrument.

Items to collect:

- 1000-mg/L Boron Standard Solution
 - 200-mL volumetric flask, Class A
 - 2.00-mL volumetric pipet, Class A and pipet filler
 - Deionized water
1. Prepare a 10-mg/L boron standard solution as follows:
 - a. Use a pipet to add 2.00 mL of a 1000-mg/L boron standard solution into the volumetric flask.
 - b. Dilute to the mark with deionized water. Mix well. Prepare this solution daily.
 2. Use the test procedure to measure the concentration of the prepared standard solution.
 3. Compare the expected result to the actual result.
- Note:** The factory calibration can be adjusted slightly with the standard adjust option so that the instrument shows the expected value of the standard solution. The adjusted calibration is then used for all test results. This adjustment can increase the test accuracy when there are slight variations in the reagents or instruments.*

Method performance

The method performance data that follows was derived from laboratory tests that were measured on a spectrophotometer during ideal test conditions. Users can get different results under different test conditions.

Program	Standard	Precision (95% confidence interval)	Sensitivity Concentration change per 0.010 Abs change
40	7.6 mg/L B	7.5–7.7 mg/L B	0.14 at 0.2 mg/L B; 0.16 at 7.0 mg/L B; 0.18 at 14.0 mg/L B

Summary of Method

Boron reacts with carminic acid in a sulfuric acid solution to produce a reddish to bluish color. The amount of color is directly proportional to the boron concentration. The measurement wavelength is 605 nm.

Consumables and replacement items

Required reagents

Description	Quantity/test	Unit	Item no.
BoroVer [®] 3 Boron Reagent Powder Pillow	1 pillow/1 tests	100/pkg	1417099
Sulfuric Acid, concentrated, ACS	varies	500 mL	97949
Water, deionized	varies	100 mL	27242

Required apparatus

Description	Quantity/test	Unit	Item no.
Cylinder, graduated, 50-mL	1	each	50841
Cylinder, graduated, 100-mL	1	each	50842
Flask, Erlenmeyer, 125-mL	2	each	50543
Flask, Erlenmeyer, 250-mL	1	each	50546
Pipet, volumetric, Class A, 2.00-mL	2	each	1451536
Pipet filler, safety bulb	1	each	1465100

Recommended standards

Description	Unit	Item no.
Boron Standard Solution, 1000-mg/L as B	100 mL	191442

Optional reagents and apparatus

Description	Unit	Item no.
Mixing cylinder, graduated, 25-mL	each	2088640
Flask, volumetric, Class A, 200-mL	each	1457445
Gloves, chemical resistant, size 9–9.5	pair	2410104 ¹
Pipet, TenSette [®] , 0.1–1.0 mL	each	1970001
Pipet tips for TenSette [®] Pipet, 0.1–1.0 mL	50/pkg	2185696
Pipet, volumetric, Class A, 5.00-mL	each	1451537
Pipet, volumetric Class A, 15-mL	each	1451539
Safety goggles, vented	each	2550700

¹ Other sizes available



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Outside the U.S.A. – Contact the HACH office or distributor serving you.

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