Phosphorus, Reactive (Orthophosphate)

USEPA [1], [2] PhosVer® 3 Method[3] **Method 8048**

0.06 to 5.00 mg/L PO_4^{3-} (0.02 to 1.60 mg/L P) **Test 'N Tube™ Vials**

Scope and application: For drinking water, wastewater and seawater.

[1] USEPA accepted for reporting wastewater analysis. Procedure is equivalent to USEPA and Standard Method 4500-P E for wastewater.
[2] USEPA Accepted for reporting for drinking water analysis. Procedure is an acceptable version of EPA Method 365.1, approved at 40 CFR part 141 NPDWR compliance monitoring.
[3] 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 adapter and light shield requirements for the instruments that use them.

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

Table 1 Instrument-specific information for test tubes

Instrument	Adapters	Light shield
DR 6000, DR 5000	—	—
DR 3900	—	LZV849
DR 3800, DR 2800, DR 2700	—	LZV646
DR 1900	9609900 (D[1])	—
DR 900	4846400	Cover supplied with the instrument

Before starting

Install the instrument cap on the DR 900 cell holder before ZERO or READ is pushed.
DR 3900, DR 3800, DR 2800 and DR 2700: Install the light shield in Cell Compartment #2 before this test is started.
For the best results, measure the reagent blank value for each new lot of reagent. Replace the sample with deionized water in the test procedure to determine the reagent blank value. Subtract the reagent blank value from the sample results automatically with the reagent blank adjust option.
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
PhosVer® 3 Reagent Powder Pillow	1
Reactive Phosphorus Test 'N Tube Vial	1
Funnel, micro	1

[1] The D adapter is not available with all instrument versions.

Items to collect (continued)

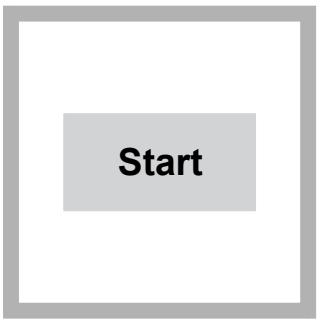
Description	Quantity
Light shield or adapter (For information about sample cells, adapters or light shields, refer to Instrument-specific information on page 1.)	1
Pipet, TenSette®, 1.0- to 10.0-mL, with pipet tips	1
Test tube rack	1

Refer to Consumables and replacement items on page 4 for order information.

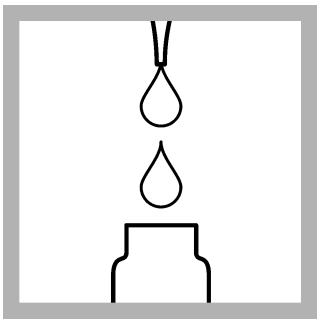
Sample collection and storage

- Collect samples in clean glass or plastic bottles that have been cleaned with 6 N (1:1) hydrochloric acid and rinsed with deionized water.
- Do not use a detergent that contains phosphate to clean the sample bottles. The phosphate in the detergent will contaminate the sample.
- Analyze the samples as soon as possible for best results.
- If immediate analysis is not possible, immediately filter and keep the samples at or below 6 °C (43 °F) for a maximum of 48 hours.
- Let the sample temperature increase to room temperature before analysis.

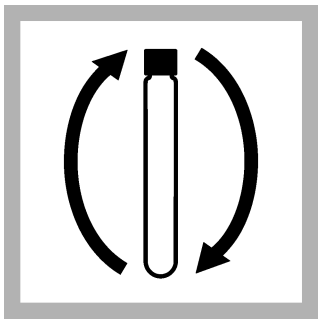
Test 'N Tube procedure



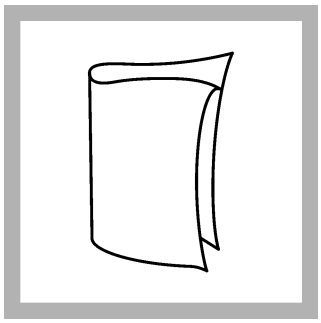
1. Start program **535 P React. PV TNT**. For information about sample cells, adapters or light shields, refer to Instrument-specific information on page 1.



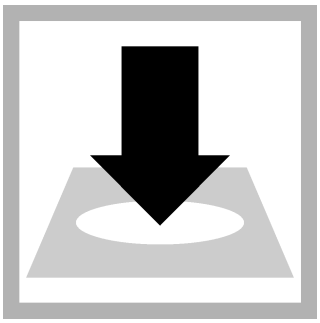
2. Add 5.0 mL of sample to a Reactive Phosphorus Test 'N Tube Vial.



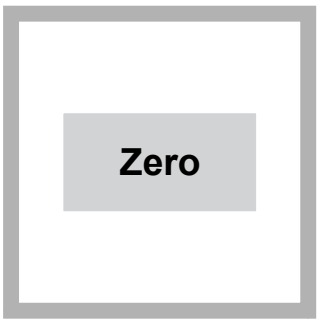
3. Put the cap on the vial. Invert to mix.



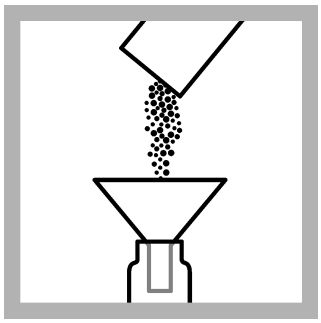
4. Clean the vial.



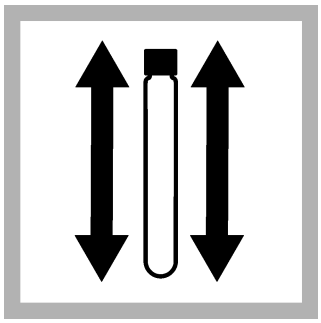
5. Insert the vial into the 16-mm cell holder.



6. Push **ZERO**. The display shows 0.00 mg/L PO_4^{3-}.



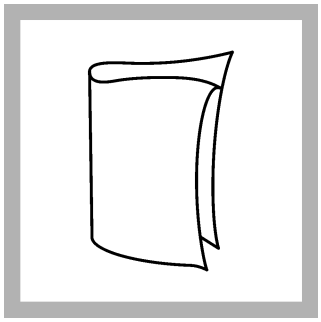
7. Add the contents of one PhosVer 3 Phosphate Powder Pillow.



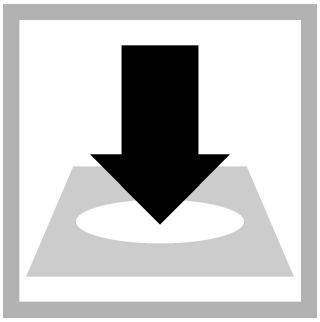
8. Put the cap on the vial. Shake for at least 20 seconds. The powder will not dissolve completely.

9. Start the instrument timer. A 2-minute reaction time starts.

Measure the sample between two and eight minutes after adding the PhosVer 3 reagent.



10. When the timer expires, clean the vial.



11. Insert the vial into the 16-mm cell holder.

12. Push **READ**. Results show in mg/L PO_4^{3-}.

Interferences

Interfering substance	Interference level
Aluminum	More than 200 mg/L
Arsenate	Interferes at any level
Chromium	More than 100 mg/L
Copper	More than 10 mg/L
Sulfide	More than 6 mg/L. Remove sulfide interference as follows: **1.** Measure 25 mL of sample into a 50-mL beaker. **2.** Swirl continuously and add bromine water by drops until a permanent yellow color is seen. **3.** Swirl continuously and add phenol solution by drops only until the yellow color is removed. Use this treated sample in the test procedure.
Iron	More than 100 mg/L
Nickel	More than 300 mg/L
Highly buffered samples or extreme sample pH	Can prevent the correct pH adjustment (of the sample) by the reagents. Sample pretreatment may be necessary.
Silica	More than 50 mg/L
Silicate	More than 10 mg/L
Turbidity or color	Samples with a high amount of turbidity can give inconsistent results. The acid in the reagents can dissolve some of the suspended particles and variable desorption of orthophosphate from the particles can occur.
Zinc	More than 80 mg/L

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:

- Phosphate 2-mL Ampule Standard, 50-mg/L as PO_4^{3-}
- Ampule breaker
- Pipet, TenSette®, 0.1–1.0 mL and tips
- Mixing cylinders, 25-mL (3)

1. Use the test procedure to measure the concentration of the sample, then keep the (unspiked) sample in the instrument.
2. Go to the Standard Additions option in the instrument menu.
3. Select the values for standard concentration, sample volume and spike volumes.
4. Open the standard solution.
5. Prepare three spiked samples: use the TenSette pipet to add 0.1 mL, 0.2 mL and 0.3 mL of the 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:

- 3.0-mg/L phosphate standard solution

1. Use the test procedure to measure the concentration of the standard solution.
2. 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 small 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
535	3.00 mg/L PO_4^{3-}	2.94–3.06 mg/L PO_4^{3-}	0.06 mg/L PO_4^{3-}

Summary of method

Orthophosphate reacts with molybdate in an acid medium to produce a mixed phosphate/molybdate complex. Ascorbic acid then reduces the complex, giving an intense molybdenum blue color. The measurement wavelength is 880 nm (DR 1900: 710 nm) for spectrophotometers or 610 nm for colorimeters.

Consumables and replacement items

Required reagents

Description	Quantity/test	Unit	Item no.
Reactive Phosphorus Test ’N Tube Reagent Set	—	50 tests	2742545
Includes:			
PhosVer 3 Phosphate Reagent Powder Pillow, 10 mL	1	50/pkg	2106046
Reactive Phosphorus Test ‘N Tube Dilution Vials (not sold separately)	1	50/pkg	—

Required apparatus

Description	Quantity/test	Unit	Item no.
Funnel, micro, poly	1	each	2584335
Pipet, TenSette, 1.0–10.0 mL	1	each	1970010
Pipet tips, for TenSette Pipet, 1.0–10.0 mL	varies	50/pkg	2199796
Test tube rack	1	each	1864100

Recommended standards and apparatus

Description	Unit	Item no.
Phosphate Standard Solution, PourRite Ampule, 50-mg/L as PO_4^{3-}, 2 mL	20/pkg	17120H
Phosphate Standard Solution, 50 mg/L as PO_4^{3-}	500 mL	17149
Phosphate Standard Solution, 1 mg/L as PO_4^{3-}	500 mL	256949
Phosphate Standard Solution, 3-mg/L as PO_4^{3-}	946 mL	2059716
Drinking Water Standard, Mixed Parameter, Inorganic for F^-, NO_3–N, PO_4^{3-}, SO_4^{2-}	500 mL	2833049
Wastewater Effluent Standard Solution, Mixed Parameter, for NH_3-N, NO_3-N, PO_4^{3-}, COD, SO_4^{2-}, TOC	500 mL	2833249
Ampule Breaker, 2-mL PourRite Ampules	each	2484600

Optional reagents and apparatus

Description	Unit	Item no.
Bromine Water, 30-g/L	29 mL	221120
Hydrochloric Acid Solution, 6.0 N (1:1)	500 mL	88449
Phenol Solution, 30-g/L	29 mL	211220
Pipet, TenSette, 0.1–1.0 mL	each	1970001
Pipet tips for TenSette Pipet, 0.1–1.0 mL	50/pkg	2185696
Pipet tips for TenSette Pipet, 0.1–1.0 mL	1000/pkg	2185628
Filter paper, folded, 3–5-micron, 12.5-cm	100/pkg	69257
Funnel, poly, 65 mm	each	108367
Thermometer, non-mercury, –10 to +225 °C	each	2635700
Bottle, sampling, with cap, low density polyethylene, 250 mL	12/pkg	2087076
Beaker, 50 mL	each	50041H

Optional standards

Description	Unit	Item no.
Ampule Breaker, 10-mL Voluette Ampules	each	2196800
Phosphate Standard Solution, 10-mg/L as PO_4^{3-}	946 mL	1420416
Phosphate Standard Solution, 15-mg/L as PO_4^{3-}	100 mL	1424342
Phosphate Standard Solution, 50-mg/L, 10-mL Voluette Ampules	16/pkg	17110
Phosphate Standard Solution, 100-mg/L as PO_4	100 mL	1436832
Phosphate Standard Solution, 10-mL ampule, 500 mg/L as PO_4	16/pkg	1424210
Phosphate Standard Solution, 500-mg/L as PO_4	100 mL	1424232

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