Photometric determination

Contents

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Applications and meter overview

Photometric determination is an important measurement procedure for routine analysis in water , production industry, and in environmental monitoring. But also, for special measurement tasks and quality control in industry, development, research and education.

● yes
✓ recommended
✓ recommended for some applications
– not recommended/not present

	Laboratory photometer				Portable photometer		
	photoLab® 7100 VIS	photoLab® 7600 UV-VIS	photoLab® S6	photolab® S12	pHotoFlex® STD	pHotoFlex® pH	pHotoFlex® Turb
Photometric determinations	●	●	●	●	●	●	●
Electrochemical pH/ORP measurement						●	●
Turbidity measurement as per DIN JSO							●
Reagent-freeReagent-free COD, nitrate, nitrite		●					
Spectrophotometer (_adjustable wave lengths)	✓	✓					
Filter photometer			✓	✓			
LED + optical filter					✓	✓	✓
6 wavelengths			✓		✓	✓	✓
12 wavelengths				✓			
IR-LED							✓
Programs for test kits	✓	✓	✓	✓	✓	✓	✓
Round cells 16/28	✓/–	✓/–	✓/–	✓/–	✓/✓	✓/✓	✓/✓
Rectangular cuvettes 10, 20, 50 mm	✓	✓		✓			
AQA support	✓	✓	✓	✓	✓	✓	✓
Barcode support	✓	✓	✓	✓	optional	optional	optional
Sample ident. Number	✓	✓	✓	✓	✓	✓	✓
Special methods NH_3, CO_2	✓	✓				✓	✓
Reagent-freesee data base correction: Reagent-free (reagent-freereagent-free COD, nitrate, nitrite)		✓					
User-defined programs	✓	✓		✓	✓	✓	✓
Comprehensive programming	✓	✓					
Multi-wavelength measurement/scans	✓	✓					
Color measurement, PC-based	✓	✓					
Coloration	✓	✓	✓	✓	✓	✓	✓
Kinetics	✓	✓		✓			
pH/ORP/Turb					–/–/–	✓/✓/–	✓/✓/✓
PC software data management + LIMS connection	✓	✓			✓	✓	✓
PC interface USB / Ethernet / RS232	✓/✓/–	✓/✓/–	–/–/✓	–/–/✓	–/–/✓	–/–/✓	–/–/✓
Battery/rechargeable battery	–/–	–/–	–/✓	–/✓	✓/–	✓/optional	✓/optional
Car battery adapter for off-line use	✓	✓					
Field case set/field case	–/✓	–/✓			✓/✓	✓/✓	✓/✓
see page	*138*	*139*	*141*	*141*	*144*	*145*	*145*

	Thermoreactors		
	CR 2200	CR 3200	CR 4200
Routine analysis	✓	✓	✓
Routine programs for wastewater/electroplating	✓	✓	✓
User-defined programs up to 170°C		✓	✓
Two different digestion programs in parallel			✓
AQA		✓	✓

Systematic and spectral analysis – routine measurement and photometric investigation

Photometric determinations can be divided into two large groups.

The **routine measurement** of measuring parameters in water analysis, also known as systematic analysis, facilitates a simple and quickly readable measurement with minimum effort using commercial test kits and the associated method data in the photometer. Thus, the analyte to be measured is transformed to a measurable colorant with the relevant reagents. The coloration results from the absorption of particular light components (wavelengths) from white light. Measurements are usually taken at the wavelength with the highest absorption.
Such routine measurements are standard tasks in water analysis of wastewater, drinking water or environmental monitoring.
Photometers and optimized test kits for various measurement ranges form a system, which is harmonized. Method data and programs as well as measuring ranges for the respective test kits are not identical in different photometer models due to the optical variations such as light sources.

Spectral analysis is particularly useful for studies of unknown substances, methods development and for optimizing testing systems: In order to, for example, determine the maximum absorption and thus the suitable wavelength for test systems, spectra are taken over a wider wavelength range. Thus, the highest peak and and most suitable absorption is detected. In addition there are investigations such as enzyme kinetics or multi-wavelength measurements. A further aspect is color measurement for the product quality analysis and assurance.

What do all of the series offer?

- **Proven quality**
- **Intuitive operation**
- **The highest precision**

Three classes of photometric instruments for different applications:
pHotoFlex® series portable LED photometers (left)
photoLab® S series filter photometers (bottom right)
photoLab® 7000 series spectrophotometers (top right)

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Portable and precise: the pHotoFlex®, photoLab® and photoLab® 7000 Series

Mobile measurement

with the pHotoFlex® Series

Measurement in changing locations is the focus. The meters are:

- energy-efficient
- robust
- portable
- precise

These requirements are backed up by special optics with a combination of LED and filters. The robustness of the portable pHotoFlex® meters is based on the low warm-up and long lifetime of LEDs used. With two cuvette sizes, the largest possible measurement ranges and the use of most common test kits are made possible using the LabStation and LSdata PC software for comfortable data management.

Lab Measurement

with photoLab® S6/S12 and the photoLab® 7000 Series

Highest standards are required in the laboratory as basis of research, routine measurements and to ensure effluent compliance. To meet these needs, the instruments offer:

- AQA/IQC
- precise measurement
- wide measurement ranges
- convenience features, such as test and cuvette recognition.
- The reference beam optics and stable laboratory temperatures enable full pre-settings with higher work comfort.

Additional features of the photoLab® 7000 Series:

- Testing from 190 – 1100 nm
- Reagent-free measurement of COD, nitrate and nitrite
- AQA and user administration
- Spectra, kinetics and multi-wavelength readings
- Data transfer via USB, even in large user environments

Photometer applications

	Portable photometers			Filter photometer		Spectrophotometers	
	pHotoFlex®			photoLab®			
	STD	pH	Turb	S6	S12	7100 UV	7600 UV-VIS
Applications / Application fields	Environmental monitoring, water analysis	Environmental monitoring, water analysis, drinks industry, wine industry, process monitoring, areas with different measurement tasks (photometry, pH, turbidity)		Routine measurements in waste and drinking water, field use optional	Routine measurements in waste and drinking water, wide-ranging laboratory testing tasks, field use optional	Spectral and special analyses in industry, teaching and research, and all analyses of routine measurements with standard parameters in waste and drinking water, as well as environmental analysis, on-site use	
Wavelengths	436, 517, 557, 594, 610, 690 nm	436, 517, 557, 594, 610, 690 nm	436, 517, 557, 594, 610, 690 nm, 860 nm (IR)	340, 445, 525, 550, 605, 690 nm	340, 410, 445, 500, 525, 550, 565, 605, 620, 665, 690, 820 nm	320 nm – 1100 nm (VIS), fully adjustable	190 nm – 1100 nm (UV-VIS), fully adjustable
Optical system	LED with filter	LED with filter	LED with filter	Filter/reference beam		Monochromator/beam-in + AutoCheck	
Special functions	–	pH/ORP	pH/ORP, turbidity	–	Kinetics	Absorption spectra, kinetics, multiple wavelength measurement, environmental parameters, routine and special measurements with AQA support, PC software photoLab® spectral data	
	optional: LabStation with LSdata PC software, rechargeable battery set, LSdata PC software (single package)						
Data sets	100	1000	1000				
Custom methods	50	100	1000	no	50	1000, 20 profiles	
Cuvettes	Round: 16 mm (variable height: 91 – 104 mm), 28 mm			Round 16 mm	Round and rectangular 10, 20, 50 mm		

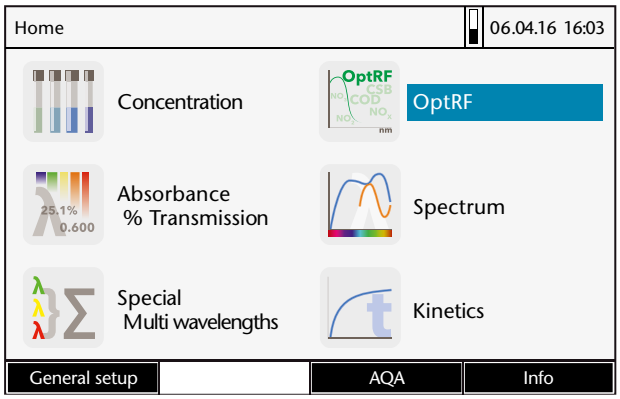
The photoLab®7000 Spectrophotometers All in one, one for all!

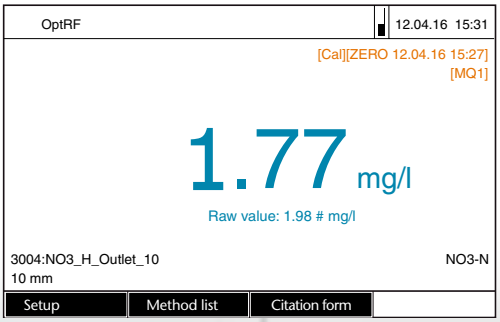
WTW spectrophotometers offer a unique combination in this instruments class of systematic and spectral analysis functions with the revolutionary reagent-free OptRF measurement for COD, nitrate and nitrite. They can be used for a wide variety of applications, from water analysis to the wine industry to science and teaching.

The quality reference beam optics ensures the greatest precision and is supported by comprehensive user management for the highest level of data security.

Thanks to the self-explanatory menu, the user can intuitively and quickly achieve the desired result:

- Bright color screen for a clear view of work processes with color-marked additional information and visual evaluations.
- Direct function call-ups via function keys F1 to F4 for standard functions such as menu-related settings, dilution, unit, etc.
- Search masks for the simplest selection of parameters, methods, etc.
- Reliable and robust tactile keypad
- Filter data for specific measurement datasets
- Input screens for user-defined methods and complex programming
- USB and Ethernet connection for data processing: Update, printing to PDFs and printers, saving and data export with LIMS connection





2 year guarantee

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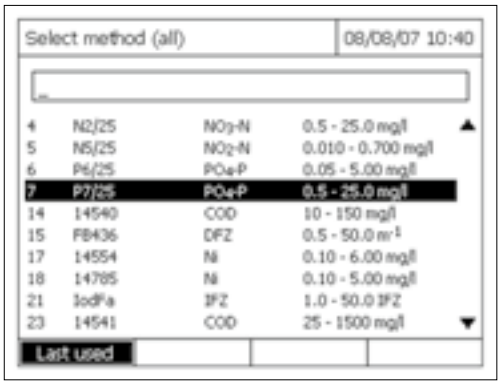
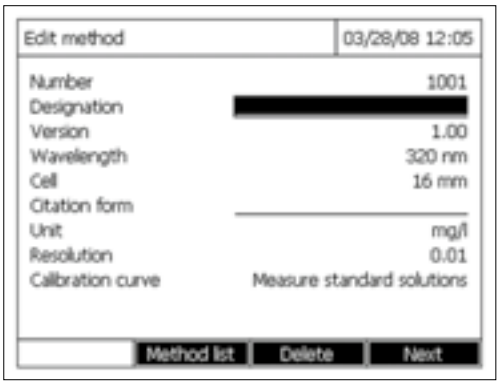
Systematic analysis - routine measurement of standard parameters

The photoLab® 7000 Series offers proven and innovative functionalities for routine measurements in water analysis as well as standard laboratory tasks.

- Round *and* rectangular cuvettes with barcode recognition for large measurement ranges
- Automatic cuvette recognition with automatic measurement range selection
- More than 250 methods for commercial test kits
- Direct methods such as SAC, UVT, coloring
- Color measurement as per APHA 2120F
- Application packets and methods such as chlorophyll, brewing trade, etc.
- Custom routine methods
- OptRF: Unique optical reagent-free measurement of COD, nitrate and nitrite with photoLab® 7600

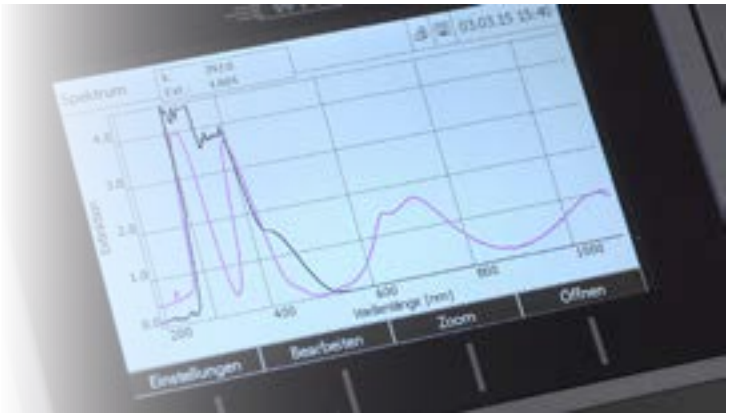




Spectral analysis – from spectra to kinetics to programming

The photoLab® 7000 Series facilitates comprehensive laboratory analysis from water to research and teaching, even when on the go:

- Optical reagent-free measurement (OptRF) of COD, nitrate and nitrite via spectral measurement with evaluation between 200 and 390 nm,
- Kinetics with maximum or freely adjustable measurement count, time intervals and start delay.
- Spectra with custom definable wavelength range
- Multiple wavelength measurements
- Special tasks/form inputs for comprehensive measurement processes
- 20 profiles and 6 colors can be saved

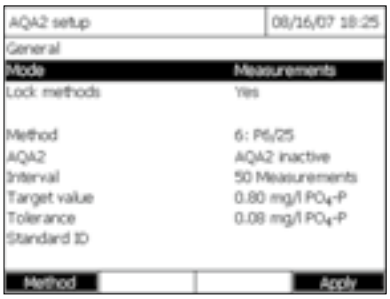


Analytic quality assurance – for result security

Analytic quality assurance (AQA) has become a must for all branches of industry to ensure and document plausible and correct measurement results.

The photoLab® 7000 Series enables AQA with monitoring of the photometer and measurements. AQA can be switched on and off as desired and offers a monitoring function through:

- Administrator, user and guest rights
- Adjustable inspection intervals for Photometer and test kits
- PhotoCheck: Photometer check incl. check for linearity (3 wavelengths at 4 measurement points)
- Selection for gray filter and test standards
- Standards for individual parameters and CombiChecks
- Matrix check with pile-up



- **Comprehensive test equipment**
- **MatrixCheck documentation**
- **User management**

IQ LabLink – the connection to the IQ Sensor Net process monitoring system

IQ LabLink creates an automatic connection between the WTW IQ Sensor Net process monitoring system and photometric laboratory measurement.

As all wastewater has a specific material composition (matrix), from time to time a fine adjustment of the online measurement is carried out via a matrix adjustment. The values for the matrix adjustment are determined with a photometer and transferred back to the correct sensor – without any cable clutter!

- Simple selection of the measurement settings
- Clearly listed multiple measurements
- Data output with commentary function

- **Comfortable and menu-prompted reconciliation procedure**
- **Secure and fast data transfer via USB**
- **Automatic allocation when several sensors are used**

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photoLab® color – color measurement instead of color perception

The photometric color measurement stands out in comparison to the visual procedure due to its objective and precise measurement: photoLab® color enables PC-controlled color measurement with the spectrophotometers of the photoLab® 6000 and 7000 Series for the quality control of substances from water to wine or from resin to sugar.

photoLab® color shines with its easy method selection and clearly listed multiple measurements with data output and commentary options. Supported measurements include CIE 15:2004, ADMI, Hazen, Yellowness, Gardner, etc.

photoLab® color

- **PC-controlled**
- **Conforming to standards**
- **CSV and PDF export**

photoLab® *Data spectral* – data management made simple

The PC software module photoLab® Data spectral is for the photometers of the photoLab® 6000/7000 Series photometers. It offers a clear interface for easy data exchange between PCs and photometers as well as the GLP compliant further processing of datasets with LIMS or spreadsheet programs.

Brewery application package for the photoLab® 6000/7000 Series

The package contains MEBAK standard methods for the measurement of the typical parameters in the brewing industry (EBC)

α-acids	Standard methods
Anthocyanins (Harris - Rickett method)	EBC
Bear measurement in beer*	EBC
Beer coloring	EBC
Beer measurement in wort*	EBC
Copper	EBC, cuprethol method
Flavonoids	EBC
Free amino nitrogen (FAN) in darker beers	EBC (with notification)
Free amino nitrogen (FAN) in darker worts	EBC (with notification)
Free amino nitrogen (FAN) in light beer	EBC (with notification)
Free amino nitrogen (FAN) in light worts	EBC (with notification)
Iron	EBC methods with calibration line
Iso-α-acids (only with photoLab® 7600 UV-VIS!)	Multiple wavelength method
Nickel	EBC
Photometric iodine test	Method with adjustment factor
Reduction capacity	
Steam-volatile phenols	Methods with calibration line
Thiobarbituric acid count TBA in beer and wort	
Thiobarbituric acid count TBA in congress wort	
Total carbohydrate	EBC
Total polyphenols	EBC
Vicinal diketones (diacetyl, 2,3-pentanedione)	EBC

photoLab® 7100 VIS Spectrophotometer – Simplifying the routine

photoLab® 7100 VIS

- **320 - 1100 nm**
- **More than 250 standard methods**
- **Special methods**
- **Color measurement**

From aquaculture to environmental monitoring

Fast and cost-effective routine analysis with AQA for wastewater, drinking water, environmental monitoring, and monitoring authorities as well as special procedures for environmental parameters such as chlorophyll or industrial fish farming.

From wine to science

Menu based guidance makes complex application procedures in the food and beverage industry, production operations, or service laboratories fast, simple, and clear.

- Preprogrammed multi-step or multiple wavelength methods
- Comprehensive programming options for user applications
- Absorption spectra and kinetics measurements
- Instruction in essentials and modern photometrics in teaching and training.
- Complex color measurement with the PC-based software photoLab® color (see page143).

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photoLab® 7600 UV-VIS Spectrophotometer - with OptRF

photoLab® 7600 UV-VIS

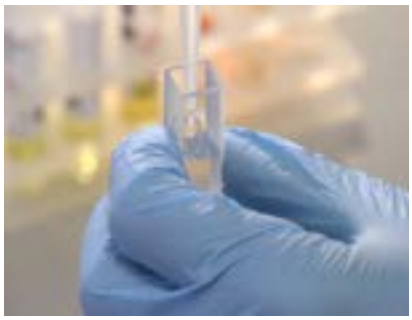
The photoLab® 7600 UV-VIS spectrophotometers combines tried and tested routine functions with pathbreaking spectral analytical functions and OptRF for reagent-free measurement. It is the one system for reference measurements for process systems to special applications in laboratory analysis.

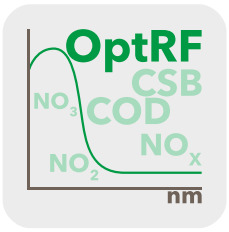
- **190 – 1100 nm**
- **OptRF reagent free menthods for COD, NO_3, NO_2**
- **Comprehensive programming options**

OptRF – optical reagent-free measurement of COD, nitrate and nitrite

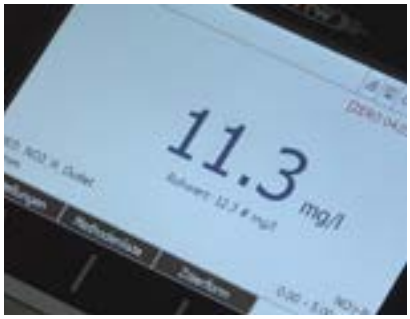
OptRF has brought online measurement into the laboratory: COD, nitrate and nitrite can by recorded, calculated, and immediately displayed as a measurement value using a spectral scan in a quartz cuvette. The range of application for OptRF include:

- Communal wastewater treatment plants and, partially, septic tanks
- Many surface waters (COD, NO_3; after pre-tests)
- Cost-free measurement range check for routine analysis
- Quick reference measurement for the matrix adjustment of online sensors





- **Faster than the fastest digestion**
- **Free of cost due to no reagents or chemicals**
- **Environmentally-friendly and harmless to health**



UVT and SAC

These parameters are increasingly important for checking UV disinfection as well as monitoring of the organic load: There are a total of five methods with and without turbidity adjustment available.

From training to the sugar industry

There are special methods and comprehensive programming for user-defined applications available for varied and mixed tasks in the range of 190 – 1100 nm. This supports universities in research and training, mixed applications in the food and beverage production industries, or service laboratories with specialist tasks.

Reagents from A to Z – for every application the right test kit

Depending on the application, there are a variety of test kits available for routine investigations. Photometers and test kits together form a system in which each is coordinated with the other depending on optics and the wavelength used, and which offers various advantages:

For use with in-the-field photometers, test kits must be simple: The energy-efficient LED optics facilitate the monitoring process via the use of often simpler and more cost-effective test kits, for example, for a powder test. In the laboratory, on the other hand, the elaborate instrument technology with barcodes and the highest level of optical sensitivity is also mirrored in the highly-precise test kits available: through the use of barcodes, lot certificates and quality assurance support.

The reagent offering is continuously expanding with the development of new tests and inclusion of existing tests in the photometer offering. Just as important as selecting the right reagent is understanding that the instrument technology may impact the test range, depending on light source and optics. For example, LED photometers typically have a smaller measurement range vs. other light sources for the same test.

Reagents for routine tests

- **Quick, reliable, cost-effective**
- **The right test for every application**
- **Guaranteed results through AQA/IQC**

Measure correctly

Most errors result from the selection of the incorrect measurement range: Measurement tolerance increases closer to the upper and lower ends of the measurement range. This is particularly significant in the lower range. Lot certificates show borders and key procedural data. So, once again, please measure with the right test kit!

Test type overview

Labeling: ● = round cuvette test TC = cuvette test TP = powder test ■ = reagent tests

Type	Cuvette test	Reagent test	Powder test
Lot certificate	With certificate (●) for the highest precision Without certificate (TC) for very good precision	With certificate (■) for the highest precision	Without certificate (TP), precise
Test recognition	Barcode (●) and/or method selection	Barcode and/or method selection	Method selection, barcode optional (external)
Advantages:	Reaction cuvette with barcode or method selection, 16 mm: Sample addition, insertion, measurement and reading with minimum work effort AQA support for stored results	Large measurement range for 10, 20 and 50 mm rectangular cuvettes, recording of the smallest concentrations in rectangular cuvettes up to 50 mm AQA support for stored results	Lowest pack size, simple test procedure, few utensils, for cuvettes in Ø 16 and 28 mm
Area of application:	Laboratory, infrequent work, or ease with very large sample sizes	Laboratory, low concentrations, routine, cost-effective work with very large sample sizes	Portable field measurements, screening and monitoring tasks

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Reagents

	Model	Measurement range (max. specification)	Cuvette (mm)1) depending on photometer	ml	Order No.	Total	CC	SW	photoLab® S6	photoLab® S12	photoLab® 6000/7000	pHotoFlex®
Aluminum Al												
●	00594	0.02 - 0.50 mg/l Al	16	6	252068	25	–	✔	–	●	●	–
■	14825	0.020 - 1.20 mg/l Al	10, 20, 50, 28	5	250425	300	✔	✔	–	●	●	●
TP	Al-1 TP	0.002 - 0.250 mg/l Al	28	20	251400	100	–	–	–	–	–	●
Ammonia NH_3 (dependent on pH value and temperature)												
●	14544	0.09 - 3.00 mg/l NH_3 (pH 8.5/25 °C) 0.5 - 16.0 mg/l NH_4-N	16	0.5	250329	25	✔	✔	–	–	●	●
■	14752/1	0.002 - 0.730 mg/l NH_3 (pH 8.5/25 °C) 0.010 - 3.00 mg/l NH_4-N	10, 20, 50 , 16, 28	5	250426	500	✔	✔	–	–	●	●
■	14752/2	0.002 - 0.730 mg/l NH_3 (pH 8.5/25 °C) 0.010 - 3.00 mg/l NH_4-N	10, 20, 50 , 16, 28	5	252081	250	✔	✔	–	–	●	●
TP	NH_4-1 TP	0.01 - 0.50 mg/l NH_4-N 0.013 - 0.64 mg/l NH_4^+	28	10	251408	200	–	–	–	–	–	●
TC	NH_4-2 TC (LR)	0.02 - 2.50 mg/l NH_4-N 0.03 - 3.20 mg/l NH_4^+	16	2	251997	50	–	–	–	–	–	●
TC	NH_4-3 TC (HR)	0.4 - 50.0 mg/l NH_4-N 0.5 - 64.4 mg/l NH_4^+	16	0.1	251998	50	–	–	–	–	–	●
Ammonium NH_4												
●	14739	0.010 - 2,000 mg/l NH_4-N 0.01 - 2.58 mg/l NH_4^+	16	5	250495	25	✔	–	●	●	●	–
●	A6/25	0.20 - 8.00 mg/l NH_4-N 0.26 - 10.3 mg/l NH_4^+	16	1	252072	25	✔	✔	●	●	●	●
●	14544	0.5 - 16.0 mg/l NH_4-N 0.6 - 20.6 mg/l NH_4^+	16	0.5	250329	25	✔	✔	●	●	●	●
●	14559	4.0 - 80.0 mg/l NH_4-N 5.2 - 103.0 mg/l NH_4^+	16	0.1	250424	25	✔	✔	●	●	●	–
■	14752/1	0.010 - 3.00 mg/l NH_4-N 0.013 - 3.86 mg/l NH_4^+	10, 20, 50, 16, 28	5	250426	500	✔	✔	–	●	●	●
■	14752/2	0.010 - 3.00 mg/l NH_4-N 0.013 - 3.86 mg/l NH_4^+	10, 20, 50, 16, 28	5	252081	250	✔	✔	–	●	●	●
■	00683	2.0 - 150 mg/l NH_4-N 2.6 - 193 mg/l NH_4^+	10	0.1, 0.2	252027	100	✔	✔	–	●	●	–
TP	NH_4-1 TP	0.01 - 0.50 mg/l NH_4-N 0.013 - 0.64 mg/l NH_4^+	20, 28	10	251408	200	–	–	–	–	●	●
TC	NH_4-2 TC (LR)	0.02 - 2.50 mg/l NH_4-N 0.03 - 3.20 mg/l NH_4^+	16	2	251997	50	–	–	–	–	●	●
TC	NH_4-3 TC (HR)	0.4 - 50.0 mg/l NH_4-N 0.5 - 64.4 mg/l NH_4^+	16	0.1	251998	50	–	–	–	–	●	●
Antimony: request application documents												
AOX												
●	00675	0.05-2,50 mg/l AOX	16		252023	25	–	–	●	●	●	–
Arsenic												
■	01747	0.001 - 0.100 mg/l As	10, 20, 16	350	252063	30	–	–	–	●	●	●
in addition:	AS absorption pipe required				252066							
Ascorbic acid: request application documents												

● = round cuvette test; ■ = reagent tests; TC = cuvette test; TP = powder test; CC = CombiCheck; SW = sea water; ml = sample volume (photoLab®); 1) Ø 16, 28; □ 10, 20, 50

	Model	Measurement range (max. specification)	Cuvette (mm)1) depending on photometer	ml	Order No.	Total	CC	SW	photoLab® S6	photoLab® S12	photoLab® 6000/7000	pHotoFlex®
BOD (Biochemical Oxygen Demand)												
●	00687	0.5 - 3000 mg/l BOD	16	-	252028	50	–	✔	●	●	●	–
Boron B												
●	00826	0.05 - 2.00 mg/l B	16	4	252041	25	–	✔	–	●	●	–
■	14839	0.050 - 0.800 mg/l B	10	5	250427	60	–	–	–	●	●	–
Bromate Br_2												
■	00605	0.020 - 10.00 mg/l Br_2	10, 20, 50	10	252014	200	–	–	–	●	●	–
Bromate: request application documents												
Cadmium Cd												
●	14834	0.025 - 1.000 mg/l Cd	16	5	250314	25	✔	–	●	●	●	●
■	01745	0.002- 0.500 mg/l Cd	10, 20, 50, 28	10	252051	55	–	–	–	●	●	●
Calcium Ca												
■	14815	1.0 - 160 mg/l Ca	10, 20, 16, 28	0.1	250428	100	–	✔	–	●	●	●
●	00858	10 - 250 mg/l Ca	16	1	252047	25	–	–	●	●	●	–
Carbon dioxide CO_2 (dependent on pH value and temperature)												
● / ■	01758	14 - 275 mg/l CO_2 (pH 6.5/18.6 °C) $KS_{4.3}$ 0.40 - 8.00 mmol/l	16	1	252087	120	–	–	–	–	●	●
Chloride Cl												
●	14730	5 - 125 mg/l Cl	16	1	250353	25	✔	✔	●	●	●	●
■	14897/1	2.5 - 250 mg/l Cl	10, 16	1, 5	250491	100	✔	✔	–	●	●	●
■	14897/2	2.5 - 250 mg/l Cl	10, 16	1, 5	252082	175	✔	✔	–	●	●	●
Chlorine Cl_2		*(f = free, t = total)*	*200* = 100 Cl_2 free + 100 Cl_2 total*									
●	00595	0.03 - 6.00 Cl_2, f	16	5	250419	200	–	–	●	●	●	●
●	00597	0.03 - 6.00 Cl_2, f+t	16	5	250420	200*	–	–	●	●	●	●
■	00598/1	0.010 - 6.00 Cl_2, f	10, 20, 50	10	252010	1200	–	–	–	●	●	–
■	00598/2	0.010 - 6.00 Cl_2, f	10, 20, 50	10	252011	200	–	–	–	●	●	–
■	00599	0.010 - 6.00 Cl_2, f+t	10, 20, 50	10	252012	200*	–	–	–	●	●	–
■	00602/1	0.010 - 6.00 Cl_2, t	10, 20, 50	10	252013	200	–	–	–	●	●	–
■	00602/2	0.010 - 6.00 Cl_2, t	10, 20, 50	10	252055	1200	–	–	–	●	●	–
TP	Cl_2-1 TP	0.02 - 2.00 mg/l Cl_2, f	20, 28	10	251401	100	–	–	–	–	●	●
TP	Cl_2-2 TP	0.5 - 5.0 mg/l Cl_2, f	20, 28	25	251402	100	–	–	–	–	●	●
TP	Cl_2-3 TP	0.02 - 2.00 mg/l Cl_2, t	20, 28	10	251414	100	–	–	–	–	●	●
TP	Cl_2-4 TP	0.5 - 5.0 mg/l Cl_2, t	20, 28	10 +15 H_20	251415	100	–	–	–	–	●	●
Chlorine dioxide ClO_2												
■	00608	0.020 - 10.00 mg/l ClO_2	10, 20, 50, 16, 28	10	252017	200	–	–	–	●	●	●
Chlorine fluid test (free and total) Cl_2												
● / ■		0.010 - 6.00 Cl_2	16, 50	10			–	–	●	●	●	–
	00086 Reagent Cl_2-1				252077	200						
	00087 Reagent Cl_2-2				252078	400						

● = round cuvette test; ■ = reagent tests; TC = cuvette test; TP = powder test; CC = CombiCheck; SW = sea water; ml = sample volume (photoLab®); 1) Ø 16, 28 ▫ 10, 20, 50

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	Model	Measurement range (max. specification)	Cuvette (mm)1) depending on photometer	ml	Order No.	Total	CC	SW	photoLab® S6	photoLab® S12	photoLab® 6000/7000	pHotoFlex®
	00088 Reagent Cl_2-3				252079	600						
	00089 Accessories Cl_2 (empty cuvettes etc.)				252080	25						
Chromate (chrome VI and total chrome) Cr												
●	14552	0.05 - 2.00 mg/l Cr	16	10	250341	25	–	✔	●	●	●	●
■	14758	0.01 - 3.00 mg/l Cr	10, 20, 50	5	250433	250	–	✔	–	●	●	–
Chrome bath CrO_3: see reagent-free tests												
COD Chemical Oxygen Demand												
●	14560	4.0 - 40.0 mg/l COD (148 °C, 2 h)	16	3	250303	25	✔	–	●	●	●	–
●	01796	5.0 - 80.0 mg/l COD (148 °C, 2 h)	16	2	252092	25	✔	–	●	●	●	–
●	C3/25	10 - 150 mg/l COD (148 °C, 2 h)	16	3	252070	25	✔	–	●	●	●	●
●	14895	15 - 300 mg/l COD (148 °C, 2 h)	16	2	250359	25	✔	–	●	●	●	●
●	14690	50 - 500 mg/l COD (148 °C, 2 h)	16	2	250304	25	✔	–	●	●	●	●
●	C4/25	25 - 1500 mg/l COD (148 °C, 2 h)	16	3	252071	25	✔	–	●	●	●	●
●	14691	300 - 3500 mg/l COD (148 °C, 2 h)	16	2	250351	25	✔	–	●	●	●	●
●	14555	500 - 10000 mg/l COD (148 °C, 2 h)	16	1	250309	25	✔	–	●	●	●	●
●	01797	5000 - 90000 mg/l COD (148 °C, 2 h)	16	0.1	252093	25	–	–	●	●	●	●
TC	COD1 TC (LR)	3 - 150 mg/l COD (148 °C, 2 h)	16	2	251990	25	–	–	–	–	●	●
TC	COD2 TC (MR)	20 - 1500 mg/l COD (148 °C, 2 h)	16	2	251991	25	–	–	–	–	●	●
TC	COD3 TC (HR)	200 - 15000 mg/l COD (148°C, 2h)	16	0.2	251992	25	–	–	–	–	●	●
COD Chemical Oxygen Demand (quicksilver-free, chloride is also recorded and/or disrupts in higher concentrations)												
●	09772	10 - 150 mg/l COD (148 °C, 2h)	16	2	250301	25	✔	–	●	●	●	●
●	09773	100 - 1500 mg/l COD (148 °C, 2h)	16	2	250306	25	✔	–	●	●	●	●
Copper bath Cu: see reagent-free tests												
Copper Cu												
●	14553	0.05 - 8.00 mg/l Cu	16	5	250408	25	–	✔	●	●	●	●
■	14767	0.02 - 6.00 mg/l Cu	10, 20, 50, 16, 28	10	250441	250	–	✔	–	●	●	●
TP	Cu-1 TP	0.04 - 5.00 mg/l Cu	20, 28	10	251403	100	–	✔	–	–	●	●
Cyanide (free and easily released cyanide) CN												
●	14561	0.010 - 0.500 mg/l CN	16	5	250344	25	–	–	●	●	●	●
■	09701	0.002 - 0.500 mg/l CN	10, 20, 50	5, 10	250492	100	–	–	–	●	●	–

● = round cuvette test; TC = cuvette test; CC = CombiCheck; ml = sample volume (photoLab®); 1) Ø 16, 28
■ = reagent tests; TP = powder test; SW = sea water; □ 10, 20, 50

	Model	Measurement range (max. specification)	Cuvette (mm)1) depending on photometer	ml	Order No.	Total	CC	SW	photoLab® S6	photoLab® S12	photoLab® 6000/7000	pHotoFlex®
Cyanuric acid												
■	19253	2 - 160 mg/l cyanuric acid	20	5	252091	100	–	–	–	●	●	–
DEHA/oxygen binder												
■	19251	0.020 - 0.500 mg/l DEHA	20	10	252089	200	–	–	–	●	●	–
TP	DEHA TP	0.004 - 0.450 mg/l DEHA	20, 28	25	251421	100	–	–	–	–	●	●
Detergents: see tensides: anionic, cationic, non-ionic												
Flouride F												
●	00809	0.10 - 1.80 mg/l F	16	50	252094	25	–	–	●	●	●	●
■	14598/1	0.10 - 20.0 mg/l F	10	5/0.5	252048	100	–	–	–	●	●	–
■	14598/2	0.10 - 20.0 mg/l F	10	5/0.5	252083	250	–	–	–	●	●	–
Formaldehyde HCHO												
●	14500	0.10 - 8.00 mg/l HCHO	16	2	250406	25	–	–	●	●	●	●
■	14678	0.02 - 8.00 mg/l HCHO	10, 20, 50	3	250331	100	–	–	–	●	●	–
Gold Au												
■	14821	0.5 - 12.0 mg/l Au	10, 16	2	250436	80	–	✔	–	●	●	●
Halogens (total): see chlorine Cl_2, bromide Br_2, Iodine $_2$, Chlorine dioxide ClO_2, Ozone O_3												
Hazen: see reagent-free tests: Coloring												
Heavy metals: see iron Pb, cadmium Cd, chrome Cr												
Hydrazine N_2H_4												
■	09711	0.005 - 2.00 mg/l N_2H_4	10, 20, 50	5	250493	100	–	–	–	●	●	–
TP	N_2H_4-1 TP	0.004 - 0.600 mg/l N_2H_4	20, 28	10	251416	100	–	–	–	–	●	●
Hydrogen peroxide H_2O_2												
●	14731	0.25 - 20.0 mg/l H_2O_2	16	10	250402	25	–	✔	–	●	●	–
■	18789	0.015 - 6.00 mg/l H_2O_2	10, 20	8	252067	100	–	–	–	●	●	–
Iod I_2												
■	0606	0.050 - 10.00 mg/l I_2	10, 20, 50	010	252015	200	–	–	–	●	●	–
Iodine color index: see reagent-free tests: Coloring												
Iron Fe												
●	14549	0.05 - 4.00 mg/l Fe	16	5	250349	25	✔	✔	●	●	●	●
●	14896	1.0 - 50.0 mg/l Fe	16	1	250361	25	–	–	●	●	●	●
■	14761/1	0.005 - 5.00 mg/l Fe	10, 20, 50, 16, 28	5	250435	1000	✔	✔	–	●	●	●
■	14761/2	0.005 - 5.00 mg/l Fe	10, 20, 50, 16, 28	5	250439	250	✔	✔	–	●	●	●
■	00796	0.010 - 5.00 mg/l Fe	10, 20, 50	8	252042	150	✔	✔	–	●	●	–
	Fe-1 TP	0.012 - 1.800 mg/l Fe	16, 28	10	251404	100	–	–	–	–	●	●
TP	Fe-2 TP	0.02 - 3.00 mg/l Fe	16, 28	10	251405	100	–	–	–	–	●	●
Lead Pb												
●	14833	0.10 - 5.00 mg/l Pb	16	5	250313	25	✔	–	●	●	●	–
■	09717	0.010 - 5.00 mg/l Pb	10, 20, 50, 16, 28	8	252034	50	✔		–	●	●	●

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■ = reagent tests; TP = powder test; SW = sea water; □ 10, 20, 50

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	Model	Measurement range (max. specification)	Cuvette (mm)1) depending on photometer	ml	Order No.	Total	CC	SW	photoLab® S6	photoLab® S12	photoLab® 6000/7000	pHotoFlex®
Magnesium Mg												
●	00815	5.0 - 75.0 mg/l Mg	16	1	252043	25	–	✔	●	●	●	●
Manganese Mn												
■	01739	0.005 – 2.00 mg/l Mn	10, 20, 50	8	252056	250	–	–	–	●	●	–
■	14770/1	0.01 - 10.0 mg/l Mn	10, 20, 50, 16, 28	5	250442	500	✔	✔	–	●	●	●
■	14770/2	0.01 - 10.0 mg/l Mn	10, 20, 50, 16, 28	5	252084	250	✔	✔	–	●	●	●
●	00816	0.10 - 5.00 mg/l Mn	16	7	252035	25	✔	–	●	●	●	●
TP	Mn-1 TP	0.2 - 20.0 mg/l Mn	20, 28	10	251406	100	–	–	–	–	●	●
TP	Mn-2 TP	0.007 - 0.700 mg/l Mn	20, 28	10	251417	100	–	–	–	–	●	●
Molybdenum Mo												
●	00860	0.02 - 1.00 mg/l Mo	16	10	252040	25	–	–	–	●	●	●
TP	Mo-1 TP	0.3 - 35.0 mg/l Mo	20, 28	10	251407	100	–	–	–	–	●	●
TP	Mo-2 TP	0.3 - 40.0 mg/l Mo	20, 28	25	251418	100	–	–	–	–	●	●
Monochloramine												
■	01632	0.05 - 10.0 mg/l Cl_2, t	10, 20, 50	10	252057	150	–	–	–	●	●	–
Natrium Na												
●	00885	10 - 300 mg/l Na	16	0.5	252044	25	–	–	●	●	●	●
Nickel bath: see reagent-free tests												
Nickel Ni												
●	14554	0.10 - 6.00 mg/l Ni	16	5	250409	25	✔	–	●	●	●	●
■	14785	0.02 - 5.00 mg/l Ni	10, 20, 50, 28	5	250443	250	✔	–	–	●	●	●
Nitrate NO_3												
●	14556	0.10 - 3.00 mg/l NO_3-N 0.4 - 13.3 mg/l NO_3	16	2	250411	25	✔	✔	–	●	●	●
●	N2/25	0.5 - 25.0 mg/l NO_3-N 2.2 - 110.7 mg/l NO_3	16	1	252073	25	✔	–	●	●	●	–
●	14542	0.5 - 18.0 mg/l NO_3-N 2.2 - 79.7 mg/l NO_3	16	1.5	250410	25	✔	–	●	●	●	●
●	14764	1.0 - 50.0 mg/l NO_3-N 4 - 221 mg/l NO_3	16	0.5	250347	25	✔	–	●	●	●	–
●	00614	23 - 225 mg/l NO_3-N 102 - 996 mg/l NO_3	16	0.1	252019	25	–	–	●	●	●	–
■	14942	0.2 - 17.0 mg/l NO_3-N 0.9 - 75.3 mg/l NO_3	10, 16	1	250422	50	✔	✔	–	●	●	●
■	14773	0.2 - 20.0 mg/l NO_3-N 0.9 - 88.5 mg/l NO_3	10, 20	1.5, 3	250444	100	✔	–	–	●	●	–
■	09713/1	0.10 - 25.0 mg/l NO_3-N 0.40 - 110.7 mg/l NO_3	10, 20, 50	0.5	250421	90	✔	–	–	●	●	–

● = round cuvette test; ■ = reagent tests; TC = cuvette test; TP = powder test; CC = CombiCheck; SW = sea water; ml = sample volume (photoLab®); 1) Ø 16, 28; □ 10, 20, 50

	Model	Measurement range (max. specification)	Cuvette (mm)1) depending on photometer	ml	Order No.	Total	CC	SW	photoLab® S6	photoLab® S12	photoLab® 6000/7000	pHotoFlex®
■	09713/2	0.10 - 25.0 mg/l NO_3-N 0.40 - 110.7 mg/l NO_3	10, 20, 50	0.5	252085	250	✔	–	–	●	●	–
TC	NO_3-1 TC	0.2 - 30.0 mg/l NO_3-N 1 -133.0 mg/l NO_3	16	1	251993	50	–	–	–	–	●	●
Nitrite NO_2												
●	N5/25	0.010 - 0.700 mg/l NO_2-N 2.2 - 2.30 mg/l NO_2	16	5	252074	25	–	✔	●	●	●	●
■	14776/1	0.002 - 1.00 mg/l NO_2-N 0.007 - 3.28 mg/l NO_2	10, 20, 50, 16, 28	5	250445	1000	–	✔	–	●	●	●
■	14776/2	0.002 - 1,000 mg/l NO_2-N 0.007 - 3.28 mg/l NO_2	10, 20, 50, 16, 28	5	250440	335	–	✔	–	●	●	●
●	00609	1.0 - 90.0 mg/l NO_2-N 3.3 - 295.2 mg/l NO_2	16	8	252069	25	–	–	●	●	●	–
TP	NO_2-1 TP	0.002 - 0.300 mg/l NO_2-N 0.007 - 0.985 mg/l NO_2	20, 28	10	251409	100	–	–	–	–	●	●
TC	NO_2-2 TC	0.03 - 0.60 mg/l NO_2-N (LR) 0.10 - 1.97 mg/l NO_2 (LR) 0.30 - 3.00 mg/l NO_2-N (HR) 0.99 - 9.85 mg/l NO_2 (HR)	16 16	2 0.5	251994	24	–	–	–	–	●	●
TP	NO_2-3 TP	0.002 - 0.300 mg/l NO_2-N 0.007 - 0.985 mg/l NO_2	20, 28	25	251419	100	–	–	–	–	●	●
Nitrogen (total): see total nitrogen N_{ges}												
Organic acids (volatile)												
●	01749	50-3000 mg/l	round	0.5	252096	25	–	–	●	●	●	–
● / ■	01809	50-3000 mg/l (100 °C, 15 min.)	16	0.5	252095	100	–	–	●	●	●	–
Oxygen capacity up to pH 4.3												
● / ■	01758	$KS_{4.3}$ 0.40 - 8.00 mmol/l 20 - 400 mg/l $CaCO_3$	16	1	252087	120	–	–	●	●	●	●
Oxygen O_2												
●	14694	0.5 - 12.0 mg/l O_2	16	-	250403	25	–	–	●	●	●	–
Ozone O_3												
■	00607/1	0.010 - 4.00 mg/l O_3	10, 20, 50, 16, 28	10	252016	200	–	–	–	●	●	●
■	00607/2	0.010 - 4.00 mg/l O_3	10, 20, 50, 16, 28	10	252054	1200	–	–	–	●	●	●
pH												
●	01744	pH 6.4 – 8.8	16	10	252050	280	–	✔	●	●	●	–
Phenol C_6H_5OH												
■	00856	0.002 – 0.100 mg/l C_6H_5OH 0.025 – 5.00 mg/l C_6H_5OH	20 10, 20, 50	200 10	252058	50 250	–	✔	–	●	●	–
●	14551	0.10 - 2.50 mg/l C_6H_5OH	16	10	250412	25	–	✔	–	●	●	●
Phosphate PO_4												
●	P6/25	0.05 – 5.00 mg/l PO_4-P 0.05 – 5.0 mg/l P_{ges} 0.2 - 15.3 mg/l PO_4	16	5	252075	25	✔	✔	●	●	●	●

● = round cuvette test; TC = cuvette test; CC = CombiCheck; ml = sample volume (photoLab®); 1) Ø 16, 28
■ = reagent tests; TP = powder test; SW = sea water; □ 10, 20, 50

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	Model	Measurement range (max. specification)	Cuvette (mm)1) depending on photometer	ml	Order No.	Total	CC	SW	photoLab® S6	photoLab® S12	photoLab® 6000/7000	pHotoFlex®
●	P7/25	0.5 - 25.0 mg/l PO_4-P 0.5 - 25.0 mg/l P_{ges} 1.5 - 76.7 mg/l PO_4	16	1	252076	25	✔	✔	●	●	●	●
●	14546	0.5 - 25.0 mg/l PO_4-P 1.5 - 76.7 mg/l PO_4	16	5	250413	25	✔	✔	●	●	●	●
●	00616	3.0 - 100.0 mg/l PO_4-P 9.0 - 307.0 mg/l PO_4	16	0.2	252021	25	–	✔	●	●	●	●
■	14848/1	0.005 - 5.00 mg/l PO_4-P 0.005 - 5.00 mg/l PO_4-P_{ges} 0.020 - 15.3 mg/l PO_4	10, 20, 50, 16, 28	5	250446	420	✔	✔	–	●	●	●
■	14848/2	0.005 - 5.00 mg/l PO_4-P 0.005 - 5.00 mg/l PO_4-P_{ges} 0.020 - 15.3 mg/l PO_4	10, 20, 50, 16, 28	5	252086	220	✔	✔	–	●	●	●
■	14842	0.5 - 30.0 mg/l PO_4-P 1.5 - 92.0 mg/l PO_4	10, 20	5	250447	400	–	✔	–	●	●	–
■	00798	1.0 - 100.0 mg/l PO_4-P 3.0 - 307.0 mg/l PO_4	10, 16	8	252045	100	–	✔	–	●	●	●
TP	PO_4-1 TP	0.007 - 0.800 mg/l PO_4-P 0.02 - 2.50 mg/l PO_4	20, 28	10	251410	100	–	–	–	–	●	●
TC	PO_4-2 TC	0.02 - 1.63 mg/l PO_4-P 0.06 - 5.00 mg/l PO_4	16	5	251989	50	–	–	–	–	●	●
TC	PO_4-3 TC	0.02 - 1.10 mg/l PO_4-P 0.02 - 1.10 mg/l P_{ges} (development, 100 °C) 0.06 - 3.37 mg/l PO_4	16	5	251988	50	–	–	–	–	●	●
TC	PO_4-4 TC	0.02 - 1.10 mg/l PO_4-P 0.02 - 1.10 mg/l P_{ges} (development, 100 °C) 0.06 - 3.37 mg/l PO_4	16	5	251987	50	–	–	–	–	●	●
Potassium K												
●	14562	5.0 - 50.0 mg/l K	16	2	250407	25	–	✔	●	●	●	●
●	00615	30 - 300 mg/l K	16	0.5	252020	25	–	✔	●	●	●	●
Reagent-free COD Chemical Oxygen Demand with OptRF: see page 159												
SAC see reagent-free tests												
Silica: see silicon Si												
Silicon/silica Si												
■	14794	0.005 - 5.00 mg/l Si 0.01 - 10.70 mg/l SiO_2	10, 20, 50, 16, 28	5	250438	300	–	✔	–	●	●	●
■	00857	0.5 - 500 mg/l Si 1.1 - 1070 mg/l SiO_2	10, 16	4/0.5	252046	100	–	–	–	●	●	●
TP	Si-1 TP (LR)	0.005 - 0.748 mg/l Si 0.01 - 1.60 SiO_2	20, 28	10	251411	100	–	✔	–	–	●	●
TP	Si-2 TP (HR)	0.3 - 46.7 mg/l Si 0.7 - 100 mg/l SiO_2	20, 16, 28	10	251412	100	–	✔	–	–	●	●
TP	Si-3 TP (HR)	0.5 - 93 mg/l Si 1 - 200 mg/l SiO_2	20, 28	25	251422	100	–	✔	–	–	●	●
Silver Ag												
■	14831	0.25 - 3.00 mg/l Ag (Total Ag: 100 °C oder 120 °C, 1 h) digestion reagents contained in test kit	10, 20, 16	10	250448	100	–	–	–	●	●	●

● = round cuvette test; TC = cuvette test; CC = CombiCheck; ml = sample volume (photoLab®); 1) Ø 16, 28
■ = reagent tests; TP = powder test; SW = sea water; □ 10, 20, 50

	Model	Measurement range (max. specification)	Cuvette (mm)1) depending on photometer	ml	Order No.	Total	CC	SW	photoLab® S6	photoLab® S12	photoLab® 6000/7000	pHotoFlex®
Sulfide/hydrogen sulfide S												
●	14779	0.020 - 1.50 mg/l S	10, 20, 50	5	250450	220	–	–	–	●	●	–
Sulfite SO_3												
●	14394	1.0 - 20.0 mg/l SO_3	16	3	250416	25	–	–	–	●	●	–
■	01746	1.0 - 60.0 mg/l SO_3	10	2	252053	150	–	–	–	●	●	–
Sulphate SO_4												
●	14548	5 - 250 mg/l SO_4	16	5	250414	25	✔	✔	●	●	●	●
●	00617	50 - 500 mg/l SO_4	16	2	252022	25	✔	✔	●	●	●	–
●	14564	100 - 1000 mg/l SO_4	16	1	250415	25	✔	✔	●	●	●	–
■	14791	25 - 300 mg/l SO_4	10	2.5	250449	200	✔	–	●	●	●	–
TP	SO_4-1 TP	2 - 70 mg/l SO_4	20, 28	10	251413	100	–	✔	–	–	●	●
TP	SO_4-2 TP	2 - 70 mg/l SO_4	20, 28	25	251423	100	–	✔	–	–	●	●
Tensides												
a-Ten (anion.) ●	02552	0.05 - 2.00 mg/l SDSA	16	5	252102	25	–	–	–	–	●	–
c-Ten (cation.) ●	01764	0.05 - 1.50 mg/l k-ten	16	5	252062	25	–	–	–	●	●	–
n-Ten (non-ion.) ●	01787	0.10 - 7.50 mg/l n-ten	16	4	252061	25	–	–	–	●	●	●
Tin Sn												
●	14622	0.10 - 2.50 mg/l Sn	16	5	250401	25	–	✔	–	●	●	–
TOC total organically-bound carbon												
●	14878	5.0 - 80.0 mg/l TOC	16	3	252036	25	–	–	●	●	●	–
●	14879	50 - 800 mg/l TOC	16	3	252037	25	–	–	●	●	●	–
Total nitrogen N_{ges}												
●	14537	0.5 - 15.0 mg/l N_{ges} (120 °C, 1 h)	16	10	250358	25	✔	–	●	●	●	●
●	14763	10 - 150 mg/l N_{ges} (120 °C, 1 h)	16	1	250494	25	✔	–	●	●	●	–
●	00613	0.5 - 15.0 mg/l N_{ges} (120 °C, 1 h)	16	10	252018	25	✔	–	●	●	●	–
TC	N_{tot}1 TC (LR)	0.5 - 25.0 mg/l N_{ges} (120°C, 30 min.)	16	2; 2	251995	50	–	–	–	–	●	●
TC	N_{tot}2 TC (HR)	10 - 150 mg/l N_{ges} (120°C, 30 min.)	16	0.5; 2	251996	50	–	–	–	–	●	●
Total phosphate: see phosphate PO_4												
Water hardness, TH total hardness												
●	00961	0.7 - 30.1 °d, 5 - 215 mg/l Ca	16	1	252039	25	–	–	●	●	●	●
Water hardness, RH remaining hardness												
●	14683	0.075 - 0.700 °d 0.50 - 5.00 mg/l Ca	16	4	250404	25	–	–	●	●	●	–

● = round cuvette test; ■ = reagent tests; TC = cuvette test; TP = powder test; CC = CombiCheck; SW = sea water; ml = sample volume (photoLab®); 1) Ø 16, 28 ▫ 10, 20, 50

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www.WTW.com

	Model	Measurement range (max. specification)	Cuvette (mm)1) depending on photometer	ml	Order No.	Total	CC	SW	photoLab® S6	photoLab® S12	photoLab® 6000/7000	pHotoFlex®
Zinc Zn												
●	00861	0.025 - 1.000 mg/l Zn	16	2	252049	25	–	–	●	●	●	●
●	14566	0.20 - 5.00 mg/l Zn	16	0.5	250417	25	✔	–	●	●	●	●
■	14832	0.05 - 2.50 mg/l Zn	10	5	250451	90	–	–	–	●	●	–
	06146	Extraction agent, required (zinc reagent 6)			250452	180						

● = round cuvette test; ■ = reagent tests; TC = cuvette test; TP = powder test; CC = CombiCheck; SW = sea water; ml = sample volume (photoLab®); 1) Ø 16, 28 □ 10, 20, 50

OptRF: optical reagent-free methods for COD, NO_3 and NO_2 measurements

The OptRF measurement of a liquid sample is based on a direct, spectral absorbance measurement in the UV range of 200 – 390 nm without the use of reagents. The measured spectrum is evaluated across the entire wavelength range. The concentration value calculation takes place automatically via complex algorithms and evaluation models saved as OptRF methods on the photometer. The OptRF methods available are specific for the respective measurement parameters and the application and/or measurement location.

The OptRF methods currently available have been developed and optimized for municipal wastewater treatment plant processes, and cover the following measurement parameters and measurement ranges in standard solutions:

Measurement parameters and areas of application

OptRF measurement methods	Parameter	Measurement range related to measurements in standards
3001 CODt_H_Outlet_10	COD_{total}[a]	2 - 75 mg/L
3002 CODs_H_Outlet_10	$COD_{dissolved}$[b]	2 - 75 mg/L
3003 NO3_H_Outlet_10	NO_3-N	0.1 - 3.0 mg/L
3004 NO2_H_Outlet_10	NO_2-N	0.1 - 4.0 mg/L

A user calibration can impact the borders of the measurement range for actual samples. OptRF methods can also be applied in samples with similar matrices, for example, certain surface waters. Other substances such as alcohols and sugar are not currently compatible with OptRF.

Test equipment

CombiCheck

CombiCheck solutions are ready-to-use multi-parameter standards. Every package contains a standard solution and an addition solution. Both solutions can be directly used, **without dilution,** for quality assurance.

- The standard solution ensures the accuracy of the results from the entire system: Work methods – analysis procedures – reagents – photometers.
- The addition solution allows you to check sample-dependent influences (MatrixCheck) through the measurement of the recovery rate and establishes the sample preparation necessary.

The maximum number of determinations with a **CombiCheck** standard solution depends on the test kit used. 280 determinations are always possible with the addition solution. Please take note of the instructions in the descriptions for the test kits!

Parameter	Concentration	Compatible test kit model	maximum number of determinations
Model 14676 CombiCheck 10			Order No. 250482
Ammonium	4.00 mg/l NH_4-N	A6/25 14558	90 90
Chloride	25.0 mg/l Cl	14730	90
COD	80 mg/l COD	C3/25 14540	30 30
Nitrate	2.5 mg/l NO_3-N	14556 14773	45 60
Phosphate	0.80 mg/l PO_4-P	P6/25 14543 14848	18 18 9
Sulphate	100 mg/l SO_4	14548 14791 00617	18 40 48
Model 14675 CombiCheck 20			Order No. 250483
Ammonium	12.0 mg/l NH_4-N	14544	180
Chloride	60 mg/l Cl	14730	90
COD	750 mg/l COD	C4/25 14541	30 30
Nitrate	9.0 mg/l NO_3-N	N2/25 14542 14563 14773 14942 09713	90 60 90 60 60 180
Phosphate	8.0 mg/l PO_4-P	P7/25 14729	90 90
Sulphate	500 mg/l SO_4	14564	90
Model 14695 CombiCheck 50			Order No. 250486
Ammonium	1.00 mg/l NH_4-N	14739 14752	19 19
Nitrogen	5.0 mg/l N_{ges}	14537 00613	9 9
COD	20.0 mg/l COD	14560	32

Parameter	Concentration	Compatible test kit model	maximum number of determinations
Model 14696 CombiCheck 60			Order no. 250487
COD	250 mg/l COD	14690 14895	48 48
Chloride	125 mg/l Cl	14897	96
Model 14689 CombiCheck 70			Order No. 250488
Ammonium	50.0 mg/l NH_4-N	14559 00683	950 480
COD	5,000 mg/l COD	14555	95
Nitrogen	50.0 mg/l N_{ges}	14763	95
Model 14738 CombiCheck 80			Order no. 250489
COD	1.500 mg/l COD	14691	48
Nitrate	25.0 mg/l NO_3-N	14764	190
Phosphate	15.0 mg/l PO_4-P	14729 P7/25	95 95
Model 18700 CombiCheck 90			Order No. 252501
Cadmium	0.250 mg/l Cd	01745 14834	9 19
Copper	2.00 mg/l Cu	14553 14767	19 19
Iron	1.00 mg/l Fe	14549 14761 00796	19 19 12
Manganese	1.00 mg/l Mn	14770 00816	9 13
Model 18701 CombiCheck 100			Order No. 252502
Aluminum	0.40 mg/l Al	00594 14825	16 19
Nickel	2.00 mg/l Ni	14554 14785	19 19
Lead	2.00 mg/l Pb	14833 09717	19 11
Zinc	0.75 mg/l Zn	00861 14832	9 19

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Standard solutions

Parameter	Conc. [mg/l]	Amount [ml]	Model	Order no.
Aluminum	1000	500	SL Al 19770	250460
Ammonium	1000	500	SL NH_4 19812	250461
AOX	20	85 (8–16 tests)	AOX 00680	252026
BOD	210	10 Fl. for 10 x 1l	BOD 00718	252030
Boron	1000	500	SL B 19500	250463
Cadmium	1000	500	SL Cd 19777	250464
Calcium	1000	500	SL Ca 19778	250465
Chloride	1000	500	SL Cl 19897	250466
Chromate	1000	500	SL CrO_3 19780	250468
Chrome	1000	500	SL Cr 19779	250467
COD 100	100	100	SL COD 100	252450
COD 1500	400	30	SL COD 400	252451
Copper	1000	500	SL Cu 19786	250473
Flouride	1000	500	SL F 19814	250470
Iron	1000	500	SL Fe 19781	250469
Lead	1000	500	SL Pb 19776	250462
Manganese	1000	500	SL Mn 19789	250474
Nickel	1000	500	SL Ni 19792	250475
Nitrate	1000	500	SL NO_3 19811	250476
Nitrite	1000	500	SL NO_2 19899	250477
Phosphate	1000	500	SL PO_4 19898	250478
Potassium	1000	500	SL K 70230	252471
Silica (silicon)	1000	500	SL Si 70236	252472
Silver	1000	500	SL Ag 19797	250479
Sulphate	1000	500	SL SO_4 19813	250480
TOC	1000	100	SL TOC 09017	250499
Zinc	1000	500	SL Zn 19806	250481

List of the standard solutions that required regular fresh preparation due to limited stability:

- free chlorine
- bound chlorine
- formaldehyde
- hydrazine
- hydrogen sulfide
- phenol
- silicon
- sulfide
- sulphate
- anionic tensides
- hydrogen peroxide

PhotoCheck

AQA/IQC: comprehensive test equipment for the measurement's optics and linearity!

The stable color solutions facilitate the checking of the filter and the wavelength settings 445 nm/446 nm, 520 nm/525 nm and 690 nm.

With four solutions per wavelength, the accuracy of the wavelength settings and the linearity of the absorbance measurement are checked. The check takes place quickly and easily via a simple menu-guided function.

PipeCheck

Test equipment for the right pipette volume!

The use of the pipette to be tested leads to the dilution of the relevant test solution with dist. water and compares the absorbance of the diluted solution with the absorbance of a reference solution. Pipettes with variations in volume of more than 2.5% are identified as defective.

Order information: Test equipment

Model	Description	Order No.
PhotoCheck 14693*	Test equipment for photoLab®	250490
PipeCheck 14962	Test equipment for pipette volumes	250498

*) also for pHotoFlex upon request

General instructions

- **Certificates** for test kits marked ■ (coded reagent tests) and ● (coded round cuvette tests) can be found on our homepage at www.WTW.com.
- **Storage:** If not stated otherwise, the test kit can be stored at **+15 °C to +25 °C** .
- We recommend regularly checking reagents and photometers, for example, with **PhotoCheck** and **CombiCheck.**
- Coded round cuvette tests are marked with ●. The external diameter of the cuvette is 16 mm. The round cuvette tests are quick tests with just **one** measurement range.
- Coded reagent tests are marked with ■. The measurement range specification is based on the total usable measurement range without pre-dilution of the sample and generally includes one (rectangular) cuvette switch.
- All reagent tests require a reaction vessel or RK 14/25 empty cuvettes and rectangular cuvettes.
- Not all cuvette types are recognized for the use of single-use cuvettes; We recommend the use of PMMA cuvettes (250 607).
- The labels **"TC"** and **"TP"** stand for test kits suitable for pHotoFlex® without a lot certificate. **TCs** are round cuvette tests in 16 mm cuvettes, **TPs** are powder tests and are measured depending on the measurement range in round cuvettes with external diameters of 28 or 16 mm..
- Round cuvettes are not suitable for multiple use.
- For some tests the measurement ranges are provided in a second citation form, for example, nitrate as nitrate (NO_3) and as nitrate nitrogen (NO_3-N). Further dimensions and citations forms which can be adjusted can be found in the operating manual for the photometer in use.
- Tests that require a **digestion** , for example, COD, are labeled with the digestion temperature and length (e.g. 148°C, 2 h). The WTW thermoreactors offer suitable programs for this purpose. For digestion, there are crack sets for heavy metals and total nitrogen (***see price list***).
- The current **analysis regulations** are contained in the respective packaging.

The information for DIN/ISO/EN/US EPA and precise measurement ranges for the photometer models can be found in the price list.

Reagent-free tests

% transmission

0 – 100% T, 10, 20 and 50 mm cuvettes (self absorption).

Absorbance

Absorbance is proportionally connected with the concentration of a substance held in water as per the Beer Lambert Law $E=\varepsilon(\lambda)\cdot c\cdot d$. The proportionality constant $\varepsilon(\lambda)$ depends on wavelength. These constants and further data, which are required for the determination of the substance contained in water, are stored as method data in modern photometers. The basic measurement size, however, is and remains the absorbance.

Coloring (EN ISO 7887: 1994)

If pure water is viewed under directly transmitted light from a viewpoint of several meters away, it appears to be colored light blue. This coloring can change to a variety of colors in the presence of impurities. Natural waters are usually colored yellowish-brown by iron or clay particles, or by humic substances. (A green coloring may be caused by algae). The "real" coloring of a water sample can be determined following filtration through a 0.45 µm filter.

Usually most yellowish-brown-colored waters and runoff from communal wastewater treatment plants can be measured at 436 nm. The runoff from industrial wastewater treatment plants does not show any steep or pronounced absorbance maximum. To investigate these waters, they must

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be measured at 436 nm (quicksilver line), while the other two measuring wavelengths of 525 nm and 620 nm can only deviate slightly from these wavelengths based on the filter used. The standard allows for discontinuous filter photometer measurements with spectral bandwidths from < 20 nm for measurements at 436 nm, 535 nm and 620 nm. Photometers with 445 nm- and 520 nm-interference filters with a bandwidth of 10 nm are therefore also suitable, for example. A spectrophotometer is required for comparison with the standard.

The result is provided in m^{-1} with the additional display of the measurement wavelengths and the spectral bandwidth, the water temperature, and the pH value. In some publications the result is also provided in CIT (color index transparency), which is identical to the result in m^{-1}. (DIN ISO 6271: 1988)

Clear liquids: Determination of the color index with the Platinum-Cobalt Scale (Hazen Color Index, APHA Color Index).

Spectrophotometers for the measurement of the stock solution with 430 nm, 455 nm, 480 nm and 510 nm are listed as suitable photometers. The actual measurement takes place as per the standard with a color comparison device enabling a visual comparison.

Chrome bath

Reagent-free measurement of the self-coloring of a galvanizing bath: Pipette in a 5 ml sample to a 100 ml graduated cuvette, fill up to the mark with distilled water and mix well. Pipette in 4 ml of the diluted sample to a 100 ml graduated cuvette, fill up with distilled water and mix well. Add 5 ml of the 1:500-diluted sample to a glass with a screw top, add 5 ml 40% sulfuric acid. Seal the glass and mix the contents well. Decant into a rectangular cell for measurement

Nickel bath

Reagent-free measurement of the self-coloring of a galvanizing bath: Fill a 5 ml sample with 5 ml 40% sulfuric acid in a round cuvette, seal and mix. Decant into a rectangular cell for measurement

Copper bath

Reagent-free measurement of the self-coloring of a galvanizing bath: Add a 25 ml sample to a 100 ml graduated cuvette, fill up to the mark with distilled water and mix well. Add 5 ml of the diluted sample to a glass with a screw top, add 5 ml 40% sulfuric acid. Seal the glass and mix the contents well. Decant into a rectangular cell for measurement

SAC – spectral absorption coefficient

The spectral absorption coefficient is generally designated as SAC (unit 1/m) and photometrically determined as the sum of the dissolved organic substances contained in the water. In the area of drinking water, the SAC is usually measured at a wavelength of 436 nm, and at 254 nm in the wastewater sector. In doing so, differentiation must be made between clear and turbid samples. To be noted as a limitation is the fact that this summary determination can only be sensibly applied if the qualitative composition of the substances contained in the water does not significantly change. SAC methods are available in the photoLab® 6000/7000 Series.

Further application methods for photoLab® 6000/7000

Application methods are photometric procedures usually based on completed test kits and which usually require multi-level steps. The selection of application methods is carried out manually via the input of the method number. A complete list of the programmed procedures can be found in the photometer's analysis regulations.

- ADMI color measurement
- Chlorophyll-a as per DIN
- Chlorophyll-a as per ASTM
- Chlorophyll-a, -b, -c as per ASTM
- Glucose
- TSS (total suspended solids)