CHEMICAL SOLUTIONS, Inc.

Rev. 1.05

3392 State Hwy 8, South New Berlin, NY 13843

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UV-Vis SPECTROPHOTOMETER

OPERATIONAL / PERFORMANCE QUALIFICATION SYSTEM

- OPERATING INSTRUCTIONS

Rev. 1.05

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HPLC PERFORMANCE QUALIFICATION SYSTEM
OPERATING INSTRUCTIONS

UV-VIS QUALIFICATION KIT PRODUCT DESCRIPTION:

I. INTRODUCTION:

The Wavelength Accuracy and Absorbance Qualification Kit is designed to allow the user to fully qualify a UV-Vis spectrophotometer for the following operational and performance tests, using the provided NIST-Traceable solutions and software templates.

- Absorbance Accuracy (based on NIST SRM 935a)
- Absorbance Linearity (7 concentrations over the NIST range)
- Photometric Precision
- Wavelength Accuracy (based on NIST SRM 2034)
- Wavelength Precision
- Stray Light (based on NIST SRM 2032)

By providing highly accurate, pre-made solutions as well as a protected software template (Excel based), the user will find it possible to qualify a spectrophotometer for its operational and performance characteristics very quickly and easily, while maintaining traceability to authentic NIST standards.

An advantage of this approach over sealed cuvet standards are that the user is employing his or her own laboratory cuvets. This will help to isolate out-of-specification cuvets and other laboratory problems, and thus helps form the basis for a true instrument performance qualification. The kit materials are also useful for quickly identifying out-of-specification cuvets in the laboratory, and for general instrument and procedural troubleshooting.

Sufficient materials are provided to qualify at least 10 spectrophotometers, depending upon the cell volume. There are no restrictions on the number of units that can be qualified, making the kit very economical in practice.

The methods given are based on:

- ASTM 1657-94: “Standard Practice for Testing Variable-Wavelength Photometric Detectors Used in Liquid Chromatography”.
- ASTM 925-83: “Standard Practice for the Periodic Calibration of Narrow Bandpass Spectrophotometers”.
- NIST Standard Reference Material 935a “Crystalline Potassium Dichromate for Use as an Ultraviolet Absorbance Standard”.
- NIST Standard Reference Material 2034 “Holmium Oxide Solution Wavelength Standard from 240 nm to 650 nm”.
- NIST Standard Reference Material 2032 “Crystalline Potassium Iodide Heterochromatic Stray Radiant Energy Standard for Ultraviolet Absorption Spectrophotometry”.

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WAVELENGTH AND ABSORBANCE QUALIFICATION KIT

OPERATING INSTRUCTIONS,

UV-Vis Qualification Kit Item Numbers:

Item. No.	Description:	
UVHK0201	**UV-Vis Performance Qualification Kit**	
	The following components are contained within the kit:	
	UVAL0101	Absorbance Solution No. 1, nominal 0.02 mg/mL (all 30 mL)
	UVAL0201	Absorbance Solution No. 2, nominal 0.04 mg/mL
	UVAL0301	Absorbance Solution No. 3, nominal 0.06 mg/mL
	UVAL0401	Absorbance Solution No. 4, nominal 0.08 mg/mL
	UVAL0501	Absorbance Solution No. 5, nominal 0.10 mg/mL
	UVAL0601	Absorbance Solution No. 6, nominal 0.12 mg/mL
	UVAL0701	Absorbance Solution No. 7, nominal 0.14 mg/mL
	UVAREF01	Absorbance Reference Solution, 60 mL
	PQAHOX01	Wavelength Calibration Solution, 4% Holmium Oxide, 30 mL
	UVAKI101	Stray Light Solution, 1% Potassium Iodide in water, 30 mL
	Certificate of Analysis with statement of NIST-Traceability for quantitative solutions provided above.	
Replacement Components: The Wavelength Calibration Solution is available as a separate item. The Absorbance Solution standards are available only as a set, but may be purchased separately from the wavelength calibration solution.		

For technical support and sales, contact:

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also, visit our website at www.chemicalsolutionsinc.com

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WAVELENGTH AND ABSORBANCE QUALIFICATION KIT

OPERATING INSTRUCTIONS,

IMPORTANT SAFETY INFORMATION

Material Safety Data sheets are available for downloading in pdf format on our website. Physical copies will be sent upon request.

WARNING:

THE WAVELENGTH CALIBRATION SOLUTION CONTAINS 10% PERCHLORIC ACID. PERCHLORIC ACID IS A STRONG OXIDIZING AGENT. USE APPROPRIATE EYE AND SKIN PROTECTION. DISCARD EXCESS SOLUTION BY POURING INTO A LARGE QUANTITY OF WATER, DILUTING FURTHER, THEN DISCARDING IN AN APPROPRIATE MANNER. CONCENTRATED PERCHLORIC ACID CAN CAUSE FIRE WHEN IN CONTACT WITH ORGANIC MATERIAL.

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OPERATING INSTRUCTIONS,

QUICK-START OPERATING INSTRUCTIONS

The UV-Vis Performance Qualification Kit contains all of the pre-made solutions, including Reference Solution, that is needed for a comprehensive spectrophotometer qualification. In addition, the Excel-based software is ready to accept the results, and print out a complete record, ready for review and signatures.

The general steps to be followed are similar to performing any routine spectrophotometric measurement.

1. Warm up the instrument as required.

2. Using Excel, open the Template from the supplied CD. Note that the program can be saved to your computer. It should be saved to a new filename, reflecting the current qualification activities, according to your laboratory and company requirements.

   Note that a "Demo" program is supplied, showing how to enter typical results.

3. Fill in the header information, typically including the instrument serial number, logbook reference, etc. Be sure to enter the actual solution concentrations, kit lot number and other information as provided on the CoA with the solutions. Remember to frequently save the file, to prevent loss of information.

4. Perform the actual absorbance measurements, using your own 1.0 cm cuvet, as per your normal laboratory practices. The equilibrated laboratory and solutions temperature should be in the range of 20-25ºC. An entry cell is provided on the template to enter the laboratory temperature. This need only be accurate with a degree or two.

   The actual order of the measurements does not matter. However, it is common good practice to start with the most dilute samples. The Reference must obviously be obtained first, if using a Diode Array instrument with a single cell.

   Multiple cuvet rinsings with smaller volumes will typically be more effective, and conserve the calibration solutions.

   Solutions should never be re-used, or put back into the bottles. Since this is a primary instrument calibration, no uncertainties should be introduced into the measurement process.

   For Diode Array instruments, the Wavelength Resettability Test is not really appropriate. This test is designed to detect wear and slack in a mechanical monochrometer. You might choose to leave the data blank in that situation, and enter a comment such as "NA".

5. Enter the summary data. Results should be automatically calculated. Since the template operates under Excel, you should work through Excel should you encounter printing or other problems.

   The final certificate should be printed on one page.

6. Most companies have their own internal policies regarding Excel spreadsheets. If you treat the final paper output as original data, and review it as such, this may avoid any particular restrictions on the use of Excel

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within a regulated data system.

PRINCIPLES OF OPERATION:

WAVELENGTH CALIBRATION:

For wavelength qualification/calibration, the Holmium Oxide solution is chemically identical to NIST SRM 2034, and is directly qualified against authentic NIST standards during manufacture.

The UV-Vis spectrum for NIST Standard Reference Material 2034 (4% Holmium Oxide in 10% perchloric acid) is presented in Figure 1. The official band numbers and their wavelengths are reproduced in Table 1for instrument bandwidths of 0.1 to 3 nm. UV-Vis spectrophotometers should be set to a suitable bandwidth for the wavelength qualification.

It is not possible to determine an absorbance maxima to better than about ± ½ the instrument bandwidth, a fact that should be kept in mind when setting acceptance criteria for wavelength accuracy. For lower quality instruments with band widths over 6 nm, the official NIST wavelength values can still be used for comparison, but the acceptance criteria should be set at no less than ± ½ the instrument bandwidth, or ± 3 nm in this example. The user should consult the instrument manual to determine reasonable specifications consistent with the instrument design specifications.

It is not necessary to measure all 14 bands of the Holmium Oxide. The six starred bands in Figure 1 represent those absorbance maxima that have been found to be suited for use with most instruments. The accompanying Excel template performs a linear regression on found vs. official wavelengths, to help with interpretation of wavelength deviations.

Wavelength precision (resettability) is measured by moving the monochrometer 10 nm away from the maximum of an absorbance band in the Holmium Oxide spectrum, then back to the nominal maximum, and noting the absorbance values. The % Relative Standard Deviation (or Coefficient of Variation) is calculated for 6 trials. This test is useful only for mechanical monochrometers, and should not be employed for Diode Array instruments. Note that due to the narrow bandwidths of Holmium Oxide, this test is quite sensitive to resettability errors on the order of 1-2 nm.

ABSORBANCE LINEARITY AND ACCURACY:

NIST SRM 935a, Potassium Dichromate in 0. 001N Perchloric Acid, is a recognized primary reference standard for determination of absolute absorbance accuracy, and for linearity over its published range.

Linearity of response is important, since demonstration of such linearity ensures that the instrument optics and electronics are operating properly, and are capable of producing linear standard curves. This in turn permits the use of standards and samples over a broader range when using two-point, or even one-point, calibration standards.

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WAVELENGTH AND ABSORBANCE QUALIFICATION KIT

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For Spectrophotometers, NIST publishes Apparent Specific Absorbance values (extinction coefficients), for potassium dichromate at various concentrations ranging from 0.02 - 0.20 g/kg , at 5 wavelengths - 235 nm and 313 nm (minima) and 257, 345 and 350 nm (maxima). NIST recommends that 345 nm not be used for accuracy determinations, but only for linearity, since it is near an isobestic point. The software provided in this kit supports both accuracy and linearity determinations for 235, 257, 313 and 350 nm.

A reference solution is provided in the kit, comprised of the same lot of diluent (0.001N perchloric acid) used to prepare the linearity standards.

Temperature Corrections:

The NIST published extinction coefficient values are listed in terms of g/kg of potassium dichromate. For the highest accuracy work, this creates the need for temperature corrections, since volume expansions will change the effective concentration within the pathlength as a function of solution temperature. These temperature corrections are small, but not trivial, and can combine to an uncertainty of about 0.1 - 0.2%, depending upon the conditions.

Two temperatures are involved - the solution temperature at the time of preparation of the standards, and the temperature of the solutions and cuvet at the time of measurement.

The official published NIST values are referenced to a temperature of 23.5°C. The UV-Vis Performance Qualification solutions are manufactured at a temperature of 23.5°C ± 1°C, as noted on the Certificate of Analysis.

A second temperature correction is required at the time of use. The analyst is required to note the temperature of the solutions. This temperature need not be too exact. The most practical method is to be sure the solutions and cuvet are kept near the instrument for a few hours, so that they are all thermally equilibrated to the laboratory ambient temperature in the vicinity of the instrument. Record the lab temperature near the instrument and solutions. Errors from this source will amount to about ± 0.1% for every 5°C away from 23.5°C. Thus, small individual temperature deviations from bottle to bottle, or bottle to cuvet, are tolerably small. In most laboratories, simply enter the approximate lab temperature within the range of 20°- 25°C.

If the absolute highest accuracy work is required, more careful temperature control, with thermostated cells and samples, may be employed. However, for most benchtop spectrophotometers, the above procedures will provide acceptable accuracy for all practical quantitative work.

These calculations, while not difficult, tend to be quite cumbersome. The validated software incorporates both types of temperature corrections, using lookup tables and other mathematical devices.

Absorbance Range:

The kit is designed so that the highest concentration produces absorbance values of just over 2AU at 257 nm, using a 1 cm cell. For modern research-grade instruments, % Accuracy will remain at 99% or better over this range. However, on older instruments or instruments with wide bandwidths of 2-5 nm, one will typically see the absorbance accuracy drop off to 97-98% or more at the highest concentrations. Such trends should also be evident in the Linearity results.

No absolute guidelines can be given for determination of suitable accuracy values for a particular spectrophotometer. Remember that absolute absorbance values are rarely used in practical laboratory work, as standard solutions are always run at the same time as the samples. Typically, one would expect 99%-101%

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for the highest grade instruments. However, in many laboratory situations for lower quality instruments, accuracy values of 98%-102%, or even 95%-105% would be acceptable. Sometimes changes in the accuracy of a given instrument over time are of greater significiance, indicating problems with the electronics or optics of the unit. The provided test solutions permit very rapid assessment of both the accuracy and linearity of a particular instrument, sometimes within time frames of 15 minutes or less, greatly facilitating troubleshooting .

Finally, one strong advantage of these solutions over those provided in sealed cuvets, is that the user is executing the Performance Qualification using the same cuvets as are used in the actual laboratory. Thus, errors in the absorbance accuracy may be due to defective cuvets, as well as to the instrument. The accuracy of cuvets in use can be readily compared using the same test solutions in two or more different cuvets.

Absorbance (photometric) precision is determined by removing and replacing a single cuvet filled with absorbance linearity solution number 2, and calculating the precision. This test helps to isolate problems with loose stage assemblies that allow the cuvet to move in the holder. No absolute specification can be given. However, one would expect %RSD values of better than 1% for working instruments.

STRAY LIGHT:

The official NIST standard for stray light determination, SRM 2032, is a solution of 1% Potassium Iodide in water. This solution is provided in the kit. Alternatively, some governing standards bodies utilize 1% Sodium Iodide for this test. 1% NaI is available upon special request if desired.

This kit provides for stray light determination at 240 nm, the lowest official wavelength for the NIST material. The instrument should be referenced with purified water at that wavelength, using a 1.0 cm cell. The absorbance of the 1% KI solution is then measured at this wavelength. Like the absorbance accuracy solutions, the measurement temperature should be noted, and should be kept within 21-26°C. The 1% KI is prepared at 23.5°C ± 1°C. The absorbance at 240 nm is entered into the spreadsheet, and the temperature-corrected stray light is calculated according to the official NIST SRM 2032 values.

Each instrument manufacturer publishes expected stray light levels in the operator's manual for their particular instrument, although sometimes at different wavelengths, or with different solutions than the official NIST values. Typically, well designed instruments in good condition can be expected to produce values of <0.2% at 240 nm for 1% KI at 240 nm. However, it is sometimes more important to document changes in a particular instrument's performance, due to lamp inefficiency or optical leaks. The solution provides a quick and easy means to monitor such changes if problems are suspected.

CAPILLARY ELECTROPHORESIS:

All of the described tests can be readily adapted to the Performance Qualification of a Capillary Electrophoresis instrument.

Use a bare fused silica capillary of appropriate dimensions for your particular system. Most CE systems provide a means of flushing the capillary with various solutions, either by pumping or vacuum. The various wavelength calibration or linearity solutions are introduced by means of sample vials. A method must be constructed for your particular instrument that will uniformly fill the entire capillary with each desired solution. In some cases, it may be necessary to use the provided syringe with appropriate sized tubing to physically pull the solution into the capillary. Consult your particular instrument manual for details, documenting the procedure you are decide to use.

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WAVELENGTH AND ABSORBANCE QUALIFICATION KIT

OPERATING INSTRUCTIONS,

WAVELENGTH CALIBRATION PROCEDURE - SPECTROPHOTOMETERS:

1. Fill the reference cuvet with the purified water and reference the instrument. For Diode Array or Scanning spectrophotometers, blank the entire spectrum according to your instrument instructions.

   Note that the narrowest slit width setting, consistent with good instrument operation, should be used for this test. Record the slit width and other relevant instrument settings.

2. Fill the sample cuvet with the Wavelength Calibration Solution.

3. For Diode Array or Scanning spectrophotometers, obtain the spectrum for the Wavelength Calibration Solution over the range of about 210nm-700nm, or over the wavelength range selected which will encompass the desired wavelength calibration bands for Holmium Oxide, as listed in Table 1 and Figure 1.

4. For non-scanning instruments, set the wavelength to each of the desired calibration wavelengths, then vary the wavelength at least ±5nm around the nominal wavelength, noting the absorbance readings at 1 nm increments.

5. Determine the wavelength maxima for the desired calibration wavelength bands.

6. Compare the found wavelengths against the official tabulated wavelengths (Table 1), at the nearest bandwidth settings. The provided spreadsheet template is set up to help record this information.

Acceptance Criteria:

The USP recommends a wavelength accuracy specification of ± 3 nm.

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WAVELENGTH PRECISION - SPECTROPHOTOMETERS:

NOTE: The Wavelength Precision test is only applicable to mechanical monochrometer instruments. Diode Array instruments obtain all wavelengths simultaneously, rendering this test meaningless. Simply leave the available cells in the spreadsheet template blank if not performing this test.

1. Perform this test after the wavelength accuracy has been verified.
2. Fill the cuvet with the Wavelength Calibration Solution, if it is not already filled. If not blanked already, first blank the instrument with the Reference Solution.
3. Set the detector to 278 nm, or to another suitable absorbance band from the list in Table 1.
4. Record the absorbance signal. Be sure that the signal is stable, indicating an equilibrated cuvet.
5. Change the wavelength by at least -10 nm, then bring it back to 278 nm, or other chosen wavelength.
6. Record the absorbance.
7. Repeat steps 5-6, alternating from + 10 to -10 nm, for a total of 6 absorbance readings.
8. Enter the absorbance values into the provided software, or determine the wavelength precision by calculating the % Relative Standard Deviation (%RSD, otherwise known as the Coefficient of Variation, CV) by the following equation:

$$\%RSD = \frac{Std\ Deviation\ of\ Absorbance\ Values}{Average\ Absorbance\ Value} * 100\%$$

Where the standard deviation is the sample standard deviation (n–1) of the individual absorbance readings, and the denominator is the average absorbance value.

Acceptance Criteria:

A precision of ≤ 1.0% RSD would be a typical acceptance criteria for resettability.

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OPERATING INSTRUCTIONS,

ABSORBANCE ACCURACY/LINEARITY - SPECTROPHOTOMETERS:

1. Perform the wavelength calibration procedure prior to this test.

2. Ensure that the Linearity Solutions are fully equilibrated to ambient laboratory temperature. Note the temperature of the solutions to ± 3°C. Solution temperature must be within the official NIST range of 20°C - 30°C. It is usually sufficient to measure the ambient air temperature next to the solutions, provided they are thermally equilibrated. Temperature should not vary by more than ± 3°C during the course of the validation. These constraints will limit temperature-induced errors to under 0.2%.

2. Set the wavelength to 257nm, or to one of the official absorbance bands at 235nm, 313nm, 345nm or 350nm.

3. DO NOT USE DISPOSABLE PLASTIC CUVETS FOR THIS TEST. Use only quartz cells.

4. Blank the instrument using the Absorbance Reference Solution (follow your instrument manual instructions regarding the reference cell procedure). Be sure to select and document an appropriate slit width, as well as any time constants or other necessary information.

5. Fill the sample cuvet with Absorbance Solution #1, taking care to achieve proper rinsing.

6. Record the absorbance.

7. Repeat for solution # 2-7.

8. Analyze the results using the supporting spreadsheet template, taking care to record the temperature at which the measurements were performed.

   The spreadsheet automatically plots the linearity curve and its residuals, as well as the absolute absorbance accuracy as per NIST SRM 935a, expressed as a percent of the official NIST value.

Acceptance Criteria:

An accuracy of 97%-103% should be used for most common bench spectrophotometers.

Linearity in terms of the Correlation Coefficient R should be ≥0.99.

Research-grade instruments should produce accuracy values within 98%-102%, while low quality instruments with bandwidths greater than 5 nm will be within 95%-105%.

The user is responsible for determination of appropriate acceptance criteria. The NIST published standards are stated to be accurate within about 0.2%, while the preparation concentrations are accurate to between 0.1%-0.2%. Further errors due to temperature fluctuations between bottles and the cuvet during the course of the instrument qualification will be on the order of 0.1% for up to 3°C temperature shifts.

Thus, errors on the order of at least 0.5%-0.6% are inherent for the absolute Absorbance Accuracy measurements.

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WAVELENGTH AND ABSORBANCE QUALIFICATION KIT

OPERATING INSTRUCTIONS,

STRAY LIGHT DETERMINATION SPECTROPHOTOMETERS:

1. Select a wavelength of 240 nm.
2. Using a 1.0 cm quartz cell, blank the instrument with the Reference Solution, or if already zeroed, simply continue.
3. Fill the cuvet with the 1% KI stray light solution.
4. Record the absorbance value.
5. Enter the results into the appropriate areas on the provided spreadsheet template. The solutions should be thermally equilibrated to ambient laboratory temperature prior to use.
6. The % stray light at 240 nm is reported by the spreadsheet, automatically corrected for temperature, according to NIST SRM 2032 official documentation. Note that this is the lowest wavelength supported by NIST for stray light measurement with 1% KI.

Acceptance Criteria:

Instruments vary widely in their stray light design specifications, with the highest quality (and highest priced) research instruments producing lower stray light values than more inexpensive instruments.

A typical stray light acceptance criteria for a medium grade, routine QC instruments would be $\leq$0.2%

Consult your instrument manual for further details.

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OPERATING INSTRUCTIONS,

PHOTOMETRIC PRECISION - SPECTROPHOTOMETERS:

1. Fill the cuvet with Linearity Solution #2. If not performed already, reference the instrument with the Reference Solution.

2. Set the detector to 257 nm (or other selected wavelength), noting the wavelength used.

3. Record the absorbance signal.

4. Remove and replace the sample cuvet, as per your normal laboratory practice.

5. Record the absorbance.

6. Repeat steps 4-5, for a total of 6 absorbance readings.

7. Enter the absorbance values into the provided software, or determine the wavelength precision by calculating the % Relative Standard Deviation (%RSD, otherwise known as the Coefficient of Variation, CV) by the following equation:

$$\%RSD = \frac{Std\ Deviation\ of\ Absorbance\ Values}{Average\ Absorbance\ Value} * 100\%$$

Where the standard deviation is the sample standard deviation (n–1) of the individual absorbance readings, and the denominator is the average absorbance value.

Acceptance Criteria:

A photometric precision of ≤1.0% RSD should be expected for typical spectrophotometers.

This is an instrument operational characteristic. As such, there are no absolute acceptance criteria. Record the values found in the instrument logbook. Comparison with historical values for the same instrument, or with other laboratory spectrophotometers, will be useful in determining problems with a loose cell holder or poor operator techniques.

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WAVELENGTH AND ABSORBANCE QUALIFICATION KIT

OPERATING INSTRUCTIONS,

APPENDIX 1- TABLES AND FIGURES

Table 1: Certified Wavelengths (nm) of Minimal Transmittance for 14 Absorbance Bands for Holmium Oxide (4% in 10% Perchloric Acid). From NIST published reference "Intrinsic Wavelength Standard Absorption Bands in Holmium Oxide Solution for UV Visible Molecular Absorption Spectrophotometry", John C. Travis (NIST) et. al, J. Phys. Chem. Ref. Data, Vol 34 (1) (2005), pp. 41-56.

SRM 2034 Band No.	Spectral Bandwidth (nm)		
	0.1 nm	1nm	3 nm
1	240.98	241.12	241.03
2	249.80	249.87	250.06
3	278.16	278.13	278.04
4	287.02	287.19	287.61
5	333.49	333.47	333.48
6	345.47	345.39	345.52
7	361.29	361.25	361.09
8	385.38	385.61	385.99
9	416.05	416.26	416.86
10b	452.02	451.40	451.28
11	467.78	467.82	468.11
12	485.21	485.23	485.21
13	536.43	536.56	537.19
14	640.43	640.50	641.11

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Figure 2: Spectrum of NIST SRM 2034 (lot 95) using an HP 8453 spectrophotometer (Bandwidth 1 nm). Official values are rounded to nearest nanometer. Those bands with a * are recommended as for use as calibration bands for HPLC and CE detectors.

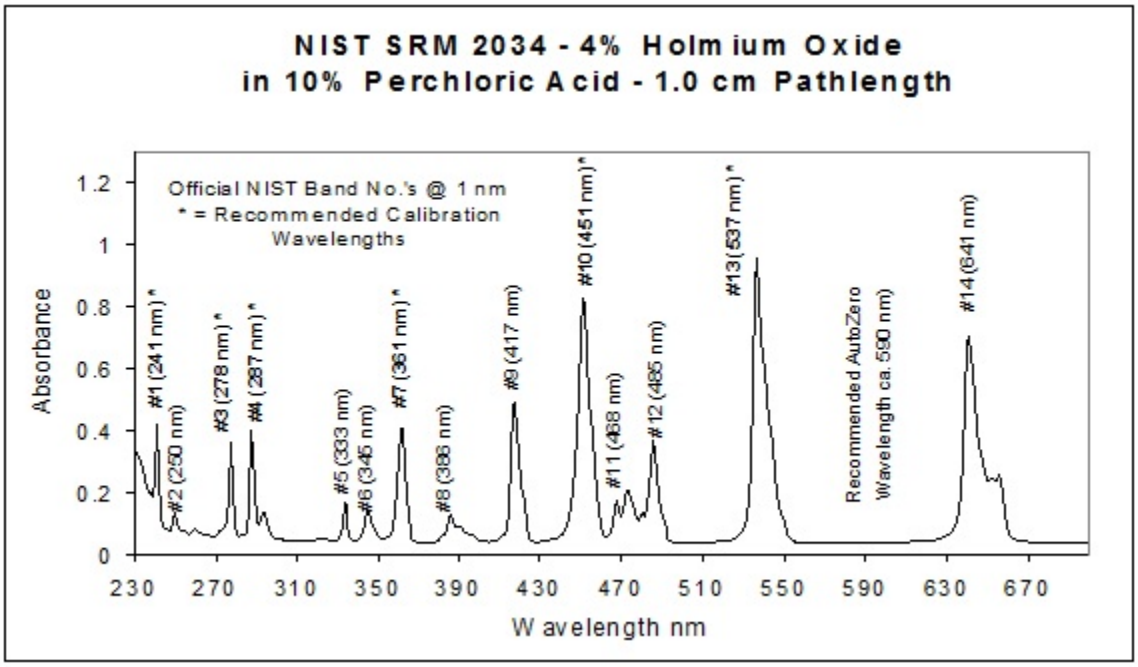

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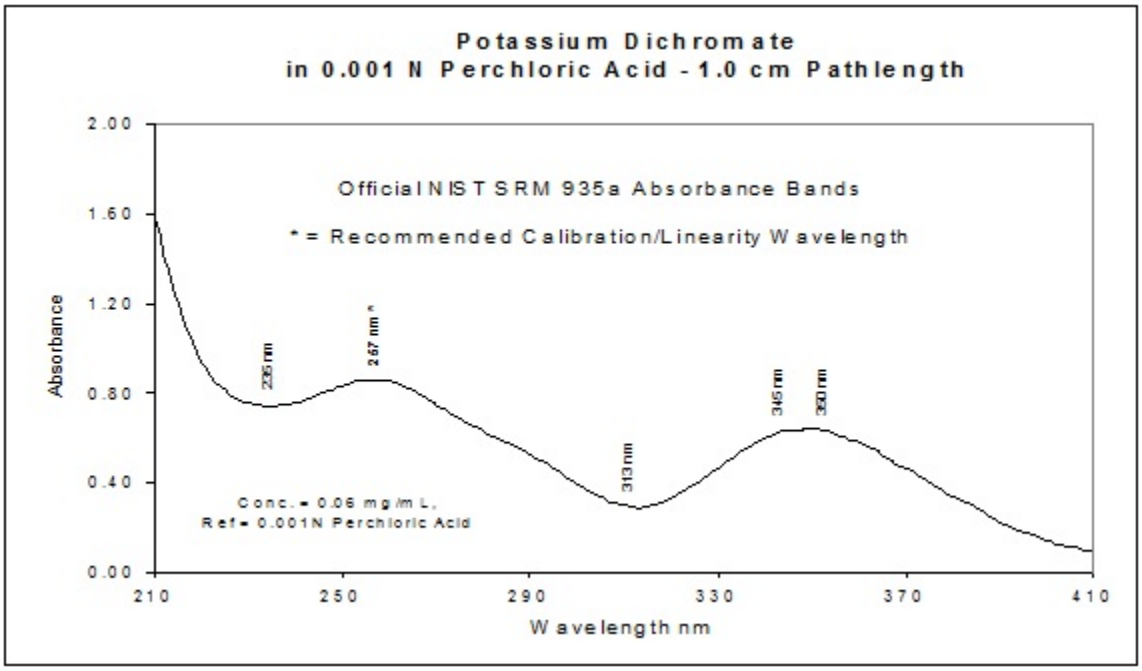
Figure 3: Spectrum of NIST SRM 935a (potassium dichromate) in 0.001N Perchloric Acid, 1 cm cell, showing the official NIST calibration wavelengths.



Forms:

The provided Excel[tm] based validated template offers a complete software product which can be used to compile and calculate all the required data. The entire spreadsheet can be printed, ready for signoff and review. Typically, this single page report is sufficient.

For those wishing to document the tests manually, example forms are provided on the following pages for a typical spectrophotometer qualification.

The UV-Vis Performance Qualification Kit can be easily incorporated into your company's Standard Operating Procedures. All of the test procedures and software may be freely copied and adapted for this purpose.

WAVELENGTH CALIBRATION FORM

Instrument: Serial Number:			Calibration Solution: Analyst/Test Date:			Other Information:											
241 nm			278 nm			287 nm			361 nm			451 nm			537 nm		
λ	Abs.	λ_{max}	λ	Abs.	λ_{max}	λ	Abs.	λ_{max}	λ	Abs.	λ_{max}	λ	Abs.	λ_{max}	λ	Abs.	λ_{max}
236			273			282			356			446			532		
237			274			283			357			447			533		
238			275			284			358			448			534		
239			276			285			359			449			535		
240			277			286			360			450			536		
241			**278**			**287**			**361**			**451**			**537**		
242			279			288			362			452			538		
243			280			289			363			453			539		
244			281			290			364			454			540		
245			282			291			365			455			541		
246			283			292			366			456			542		

LINEARITY ABSORBANCE RESULTS FORM

Instrument: Serial Number:		Analyst/Test Date:	Other Information:
Solution #:	Lot Number:	Concentration mg/mL	Absorbance at λ =
1			
2			
3			
4			
5			
6			
7			

RESULTS:

Slope:	
Intercept:	
Correlation Coefficient, R:	

Wavelength Precision

Absorbance Reading #:	Absorbance:
1	
2	
3	
4	
5	
6	
Average:	
Sample Standard Deviation (SSD):	
%RSD = (SSD/Average) * 100	

Absorbance Precision

Absorbance Reading #:	Absorbance:
1	
2	
3	
4	
5	
6	
Average:	
Sample Standard Deviation (SSD):	
%RSD = (SSD/Average) * 100	

Stray Light and Absorbance Accuracy: Use provided software.