

# National Bureau of Standards

## Certificate

### Standard Reference Material 2010a

#### Didymium Glass Filter for Checking the Wavelength Scale of Spectrophotometers

SERIAL NO. \_\_\_\_\_

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This Standard Reference Material (SRM) is a 51 x 51 x 3 mm didymium glass filter. SRM 2010a is intended for use in calibrating the wavelength scale in the visible wavelength region of scanning spectrophotometers having nominal bandwidths in the range 1.5 to 10.5 nm. Depending upon the bandwidth of the spectrophotometer, 12 to 22 wavelength corrections can be determined from 389 to 760 nm. Detailed instructions on the use of this SRM and examples of its use are given in the accompanying NBS Special Publication 260-66. Each didymium glass filter is identified by serial number.

All measurements on these filters were made at 25 °C with a high-accuracy reference spectrophotometer that has a wavelength accuracy of 0.04 nm.

Table 1 gives the wavelengths of the transmittance minima as obtained from measurements on two filters representative of this melt of didymium glass. These values are given for seven equally spaced values of the half-height width of triangular passbands. The minima numbers are shown on Figure 1, which illustrates the spectral transmittance as a function of wavelength.

Table 2 gives the wavelength values of nine points of inflection on the spectral transmittance curve as obtained on two filters. These inflection points are representative of this glass melt and are also shown on Figure 1. These inflection points should only be used with the transmittance minima as described in Sections 2.2 and 2.3 in SP 260-66. Table 2 also indicates the range of the measured wavelengths of the inflection points.

Table 3 gives the estimated random and systematic errors of the transmittance minima given in Table 1 (as obtained from 4 sets of measurements on a single filter).

Table 4 gives the spectral transmittance as a function of wavelength for a filter representative of this melt. These values are not certified but are provided for use as specified in SP 260-66. They should not be used to check the photometric scale of a spectrophotometer.

Trial calibrations made on several instruments, using both minima and inflection points, indicate that wavelength corrections made with these SRM's can be accurate to 0.2 nm. The uncertainty of a calibration, however, will depend upon the stability and other characteristics of a particular instrument.

This filter should be handled only by its edges; when not in use it should be stored in the box provided. If cleaning is necessary, wet the filter with water and rub gently with optical lens tissue soaked with a mild soap solution, rinse with distilled water, rinse with isopropyl alcohol, and rinse again with distilled water. Dry after each rinsing by wiping lightly with optical lens tissue.



**TABLE 1**  
**Certified Wavelengths (nm) of the Transmittance**  
**Minima for the Indicated Bandwidths**

Bandwidth Minimum No.	1.5 nm	3.0 nm	4.5 nm	6.0 nm	7.5 nm	9.0 nm	10.5 nm
1	--	--	--	--	--	--	--
2	431.58	--	--	--	--	--	--
3	440.78	440.98	441.41	441.94	442.19	442.17	441.87
4	--	--	--	--	--	--	--
5	472.67	472.43	472.31	--	--	--	--
6	481.20	480.68	480.37	479.67	478.36	477.26	476.18
7	513.66	513.76	513.94	514.25	514.87	--	--
8	529.37	529.47	529.26	529.11	529.08	528.98	528.74
9	573.12	573.88	574.75	575.72	--	--	--
10	585.50	585.68	585.86	586.03	585.91	585.29	584.39
11	623.85	624.42	--	--	--	--	--
12	629.51	629.26	628.17	627.17	627.17	--	--
13	684.71	684.74	684.78	684.80	684.77	684.73	684.65
14	739.61	740.20	740.58	741.33	742.55	743.50	744.16
15	748.64	748.48	--	--	--	--	--

**TABLE 2**  
**Wavelengths and Transmittances at Nine Selected**  
**Points of Inflection**

Point Identification	Wavelength (nm)	Range* (nm)	Transmittance <sup>+</sup>
A	388.68	+02 -02	0.3027
B	429.67	+06 -10	.6268
C	450.21	+03 -03	.5569
D	485.75	+08 -12	.6210
E	536.39	+04 -06	.5597
F	568.40	+06 -03	.3969
G	599.57	+02 -02	.3375
H	733.55	+05 -03	.4493
I	757.22	+01 -02	.3959

\*The range of wavelengths within which the wavelength for the given transmittance will fall for symmetric triangular passbands with half-height bandwidths from 1.5 to 10.5 nm.

+These values of transmittance are not certified.

**TABLE 3**  
**Estimated Random and Systematic Errors of the Transmittance Minima**

Band Number	Nominal Wavelength of Minimum Transmittance	Standard Deviation for Indicated Bandwidth						
		1.5 nm	3.0 nm	4.5 nm	6.0 nm	7.5 nm	9.0 nm	10.5 nm
1	402 nm	--	--	--	--	--	--	--
2	431	0.013 nm (0.06)*	0.010 nm	--	--	--	--	--
3	440	0.021 (0.05)	0.013	0.050 nm	0.028 nm	0.009 nm	0.005 nm	0.007 nm (0.25)
4	446	--	--	--	--	--	--	--
5	473	0.011 (0.08)	0.012	0.032	--	--	--	--
6	481	0.015 (0.15)	0.013	0.009	0.009	0.009	0.014	0.017 (0.25)
7	513	0.022 (0.08)	0.016	0.014	0.013	0.010	--	--
8	530	0.012 (0.21)	0.010	0.010	0.011	0.010	0.011	0.010 (0.25)
9	573	0.004 (0.05)	0.010	0.010	0.012	0.014	--	--
10	585	0.007 (0.06)	0.004	0.007	0.008	0.008	0.007	0.007 (0.25)
11	624	0.058 (0.06)	0.061	--	--	--	--	--
12	630	0.210 (0.02)	0.120	0.171	0.133	0.091	--	--
13	685	0.019 (0.05)	0.029	0.024	0.017	0.014	0.014	0.012 (0.25)
14	740	0.009 (0.25)	0.013	0.011	0.010	0.009	0.009	0.010 (0.25)
15	748	0.020 (0.04)	0.016	--	--	--	--	--

\* Values in parentheses are estimates of the systematic error. The estimates for the 1.5 nm bandwidth were obtained from the data taken at 1.5 nm intervals as compared to data taken at 0.15 nm intervals. The method of estimating the systematic errors for the 10.5 nm bandwidth is described in Section 3.4 in SP 260-66.

TABLE 4

Transmittance (T) as a function of wavelength from 380 to 780.5 nm for a bandwidth of 1.5 nm. The estimates of random and systematic errors are also provided. These data are not certified.

Wavelength (nm)	T	$\Delta T$ Standard Error	$\Delta T$ Systematic	Wavelength (nm)	T	$\Delta T$ Standard Error	$\Delta T$ Systematic
380.00	.14580	.000027	.00010	381.50	.17003	.000030	.00010
383.00	.19554	.000013	.00010	384.50	.22249	.000015	.00010
386.00	.25140	.000030	.00010	387.50	.28048	.000036	.00010
389.00	.30929	.000054	.00010	390.50	.33718	.000059	.00010
392.00	.36465	.000036	.00010	393.50	.39159	.000027	.00010
395.00	.41903	.000065	.00010	396.50	.44370	.000034	.00010
398.00	.46633	.000062	.00010	399.50	.48705	.000055	.00010
401.00	.50766	.000057	.00010	402.50	.52624	.000068	.00010
404.00	.54799	.000057	.00010	405.50	.56861	.000032	.00010
407.00	.58745	.000094	.00010	408.50	.60604	.000060	.00010
410.00	.62234	.000038	.00010	411.50	.63656	.000068	.00010
413.00	.64951	.000059	.00010	414.50	.66131	.000065	.00010
416.00	.67152	.000046	.00010	417.50	.67987	.000057	.00010
419.00	.68701	.000067	.00010	420.50	.69555	.000103	.00010
422.00	.70151	.000030	.00010	423.50	.70430	.000041	.00010
425.00	.70965	.000033	.00010	426.50	.71287	.000023	.00010
428.00	.70285	.000049	.00010	429.50	.63752	.000022	.00010
431.00	.54947	.000024	.00010	432.50	.55494	.000013	.00010
434.00	.55895	.000046	.00010	435.50	.54368	.000026	.00010
437.00	.52045	.000033	.00010	438.50	.49497	.000054	.00010
440.00	.47901	.000032	.00010	441.50	.47848	.000021	.00010
443.00	.48766	.000036	.00010	444.50	.49576	.000022	.00010
446.00	.49920	.000024	.00010	447.50	.50825	.000046	.00010
449.00	.53230	.000030	.00010	450.50	.56323	.000034	.00010
452.00	.58958	.000041	.00010	453.50	.60902	.000039	.00010
455.00	.62269	.000032	.00010	456.50	.62779	.000015	.00010
458.00	.62218	.000031	.00010	459.50	.60829	.000019	.00010
461.00	.59143	.000041	.00010	462.50	.57854	.000026	.00010
464.00	.57327	.000014	.00010	465.50	.56913	.000036	.00010
467.00	.55998	.000018	.00010	468.50	.54595	.000016	.00010
470.00	.53141	.000028	.00010	471.50	.51638	.000030	.00010
473.00	.50873	.000021	.00010	474.50	.53083	.000021	.00010
476.00	.55022	.000031	.00010	477.50	.52368	.000028	.00010
479.00	.50331	.000028	.00010	480.50	.49395	.000037	.00010
482.00	.49597	.000022	.00010	483.50	.53422	.000031	.00010
485.00	.59664	.000041	.00010	486.50	.65144	.000060	.00010
488.00	.69388	.000055	.00010	489.50	.72897	.000037	.00010
491.00	.75482	.000024	.00010	492.50	.76958	.000047	.00010
494.00	.77582	.000044	.00010	495.50	.77650	.000051	.00010
497.00	.77208	.000054	.00010	498.50	.76286	.000025	.00010

TABLE 4 (Continued)  
 Transmittance (T) as a function of wavelength from 380 to 780.5 nm for a bandwidth of 1.5 nm. The estimates of random and systematic errors are also provided. These data are not certified.

Wavelength (nm)	T	$\Delta T$ Standard Error	$\Delta T$ Systematic	Wavelength (nm)	T	$\Delta T$ Standard Error	$\Delta T$ Systematic
500.00	.75007	.000038	.00010	501.50	.73534	.000045	.00010
503.00	.71949	.000049	.00010	504.50	.70383	.000045	.00010
506.00	.68654	.000029	.00010	507.50	.66262	.000024	.00010
509.00	.62231	.000040	.00010	510.50	.56707	.000031	.00010
512.00	.51720	.000029	.00010	513.50	.49346	.000056	.00010
515.00	.50708	.000031	.00010	516.50	.53946	.000027	.00010
518.00	.56851	.000043	.00010	519.50	.58209	.000030	.00010
521.00	.57281	.000036	.00010	522.50	.51543	.000052	.00010
524.00	.43289	.000017	.00010	525.50	.39072	.000015	.00010
527.00	.37679	.000020	.00010	528.50	.35483	.000018	.00010
530.00	.35279	.000016	.00010	531.50	.37015	.000025	.00010
533.00	.39916	.000017	.00010	534.50	.45853	.000042	.00010
536.00	.54124	.000035	.00010	537.50	.61975	.000031	.00010
539.00	.68105	.000047	.00010	540.50	.72896	.000044	.00010
542.00	.76653	.000033	.00010	543.50	.79325	.000059	.00010
545.00	.81171	.000029	.00010	546.50	.82444	.000040	.00010
548.00	.83233	.000043	.00010	549.50	.83615	.000081	.00010
551.00	.83719	.000045	.00010	552.50	.83660	.000048	.00010
554.00	.83571	.000022	.00010	555.50	.83426	.000029	.00010
557.00	.83133	.000029	.00010	558.50	.82584	.000025	.00010
560.00	.81679	.000044	.00010	561.50	.80277	.000038	.00010
563.00	.78036	.000034	.00010	564.50	.74242	.000038	.00010
566.00	.67208	.000029	.00010	567.50	.53386	.000026	.00010
569.00	.31171	.000019	.00010	570.50	.11909	.000013	.00010
572.00	.04466	.000020	.00010	573.50	.03514	.000016	.00010
575.00	.04138	.000008	.00010	576.50	.04491	.000012	.00010
578.00	.05465	.000013	.00010	579.50	.06821	.000009	.00010
581.00	.06696	.000015	.00010	582.50	.04148	.000013	.00010
584.00	.01915	.000006	.00010	585.50	.01262	.000006	.00010
587.00	.01731	.000007	.00010	588.50	.03031	.000012	.00010
590.00	.04805	.000019	.00010	591.50	.06187	.000007	.00010
593.00	.08229	.000008	.00010	594.50	.12409	.000025	.00010
596.00	.18771	.000025	.00010	597.50	.25829	.000021	.00010
599.00	.31676	.000014	.00010	600.50	.37306	.000031	.00010
602.00	.43501	.000046	.00010	603.50	.49640	.000049	.00010
605.00	.55363	.000037	.00010	606.50	.59925	.000042	.00010
608.00	.63107	.000066	.00010	609.50	.65692	.000042	.00010
611.00	.68896	.000030	.00010	612.50	.73245	.000043	.00010
614.00	.78043	.000024	.00010	615.50	.82013	.000027	.00010
617.00	.84419	.000022	.00010	618.50	.85409	.000056	.00010

TABLE 4 (Continued)

Transmittance (T) as a function of wavelength from 380 to 780.5 nm for a bandwidth of 1.5 nm. The estimates of random and systematic errors are also provided. These data are not certified.

Wavelength (nm)	T	$\Delta T$ Standard Error	$\Delta T$ Systematic	Wavelength (nm)	T	$\Delta T$ Standard Error	$\Delta T$ Systematic
620.00	.85400	.000056	.00010	621.50	.84757	.000045	.00010
623.00	.84081	.000045	.00010	624.50	.84027	.000029	.00010
626.00	.84212	.000048	.00010	627.50	.84185	.000048	.00010
629.00	.83965	.000035	.00010	630.50	.84039	.000047	.00010
632.00	.84500	.000046	.00010	633.50	.85109	.000062	.00010
635.00	.85677	.000038	.00010	636.50	.86029	.000032	.00010
638.00	.86270	.000045	.00010	639.50	.86501	.000022	.00010
641.00	.86684	.000035	.00010	642.50	.86847	.000026	.00010
644.00	.86991	.000050	.00010	645.50	.87114	.000069	.00010
647.00	.87189	.000053	.00010	648.50	.87232	.000097	.00010
650.00	.87268	.000030	.00010	651.50	.87294	.000108	.00010
653.00	.87322	.000052	.00010	654.50	.87322	.000064	.00010
656.00	.87320	.000078	.00010	657.50	.87276	.000059	.00010
659.00	.87216	.000017	.00010	660.50	.87106	.000029	.00010
662.00	.86924	.000035	.00010	663.50	.86636	.000018	.00010
665.00	.86192	.000120	.00010	666.50	.85616	.000054	.00010
668.00	.84947	.000030	.00010	669.50	.84273	.000043	.00010
671.00	.83688	.000020	.00010	672.50	.83157	.000038	.00010
674.00	.82668	.000032	.00010	675.50	.82088	.000031	.00010
677.00	.81184	.000039	.00010	678.50	.79967	.000058	.00010
680.00	.78648	.000047	.00010	681.50	.77033	.000071	.00010
683.00	.75090	.000047	.00010	684.50	.73735	.000031	.00010
686.00	.74509	.000039	.00010	687.50	.76335	.000040	.00010
689.00	.77874	.000044	.00010	690.50	.79470	.000040	.00010
692.00	.81070	.000036	.00010	693.50	.82509	.000060	.00010
695.00	.83668	.000063	.00010	696.50	.84584	.000038	.00010
698.00	.85296	.000065	.00010	699.50	.85807	.000074	.00010
701.00	.86156	.000057	.00010	702.50	.86388	.000070	.00010
704.00	.86559	.000080	.00010	705.50	.86695	.000087	.00010
707.00	.86777	.000188	.00010	708.50	.86848	.000069	.00010
710.00	.86848	.000063	.00010	711.50	.86809	.000113	.00010
713.00	.86701	.000069	.00010	714.50	.86522	.000073	.00010
716.00	.86278	.000142	.00010	717.50	.85960	.000047	.00010
719.00	.85552	.000123	.00010	720.50	.85002	.000116	.00010
722.00	.84280	.000084	.00010	723.50	.83304	.000031	.00010
725.00	.81990	.000114	.00010	726.50	.80031	.000070	.00010
728.00	.77176	.000077	.00010	729.50	.72617	.000057	.00010
731.00	.65583	.000101	.00010	732.50	.54906	.000059	.00010
734.00	.41047	.000065	.00010	735.50	.27146	.000070	.00010
737.00	.17783	.000032	.00010	738.50	.14350	.000025	.00010

TABLE 4 (Continued)

Transmittance (T) as a function of wavelength from 380 to 780.5 nm for a bandwidth of 1.5 nm. The estimates of random and systematic errors are also provided. These data are not certified.

Wavelength (nm)	T	$\Delta T$ Standard Error	$\Delta T$ Systematic	Wavelength (nm)	T	$\Delta T$ Standard Error	$\Delta T$ Systematic
740.00	.14029	.000039	.00010	741.50	.14205	.000027	.00010
743.00	.15422	.000013	.00010	744.50	.17506	.000027	.00010
746.00	.17950	.000044	.00010	747.50	.16393	.000038	.00010
749.00	.15817	.000026	.00010	750.50	.17714	.000030	.00010
752.00	.21278	.000036	.00010	753.50	.25589	.000065	.00010
755.00	.30634	.000047	.00010	756.50	.36590	.000050	.00010
758.00	.42896	.000027	.00010	759.50	.48660	.000056	.00010
761.00	.53598	.000089	.00010	762.50	.57747	.000099	.00010
764.00	.61508	.000065	.00010	765.50	.65041	.000071	.00010
767.00	.68350	.000108	.00010	768.50	.71193	.000061	.00010
770.00	.73432	.000079	.00010	771.50	.75005	.000086	.00010
773.00	.76019	.000081	.00010	774.50	.76505	.000141	.00010
776.00	.76438	.000145	.00010	777.50	.75658	.000066	.00010
779.00	.74102	.000081	.00010	780.50	.71767	.000142	.00010