

## 6l. Wavelengths for Spectrographic Calibration<sup>1</sup>

TABLE 6l-1. WAVELENGTH STANDARDS FOR THE VACUUM ULTRAVIOLET\*

Wavelength, Å	Inten- sity	Spec- trum	Esti- mated relative error (±mÅ)	Wavelength, Å	Inten- sity	Spec- trum	Esti- mated relative error (±mÅ)
1,942.273 <sup>3</sup>	20	Hg II	2	1,774.941 <sup>c</sup>	20	Si I	4
1,930.902	10	C I	2	1,769.658 <sup>c</sup>	1	Si I	4
1,900.284	5	Hg II	2	1,753.113 <sup>c</sup>	2	Si I	3
1,880.969	5	Si I	2	1,749.771 <sup>c</sup>	1	Si I	5
1,870.547	20	Hg II	4	1,745.246	30	N I	3
1,869.548	8	Hg II	2	1,743.322	10	N II	4
1,867.590	1	N II	3	1,742.724	60	N I	3
1,864.742	5	N II	2	1,740.327	15	N II	3
1,862.806	2	N II	5	1,736.582	8	Si I	4
1,861.750 <sup>c</sup>	1	Si I	2	1,732.142	15	Hg II	4
1,859.406	3	Ni I	2	1,730.874	2	N I	3
1,857.956	8	Ni I	4	1,727.332 <sup>c</sup>	4	Si I	3
1,853.260	3	Si I	4	1,721.081	20	C II	3
1,850.665	5	Si I	5	1,720.158	18	C II	4
1,849.497	50R <sup>b</sup>	Hg I	4	1,707.397	4	Hg II	4
1,849.380	5	Ni I	4	1,704.558 <sup>c</sup>	4	Si I	4
1,848.237	5	Si I	4	1,702.805 <sup>c</sup>	8	Si I	4
1,846.014	8	N II	4	1,702.733	8	Hg II	4
1,844.304	10	N II	4	1,700.522	3	Si I	4
1,842.066	1	N II	5	1,693.756	15	Si I	4
1,839.995	4	Si I	4	1,676.913	5	Si I	4
1,833.264	1	C	5	1,672.405	2	Hg II	3
1,831.973	5	N II	4	1,658.117 <sup>c</sup>	20	C I	1
1,830.458	4	N II	4	1,657.899 <sup>c</sup>	15	C I	4
1,820.336	20	Hg II	4	1,657.541	1	C I	5
1,816.921	8	Si II	2	1,657.374 <sup>c</sup>	10	C I	1
1,808.003	5	Si II	4	1,657.243	1	C I	5
1,807.303	30	N II	5	1,657.001 <sup>c</sup>	30	C I	1
1,803.888	2	Hg II	2	1,656.923 <sup>c</sup>	15	C I	1
1,796.897	15	Hg II	4	1,656.454	4	C I	4
1,787.805 <sup>c</sup>	10	Si I	2	1,656.259	15	C I	1
1,782.817	15	Na III	4	1,654.055	5	C I	3
1,775.677	1	Hg I	4	1,653.644	2	Hg II	3

<sup>1</sup> This section presents calibration standards in the ultraviolet and infrared wavelength regions. For corresponding data on visible wavelengths, see Sec. 7.

## WAVELENGTHS FOR SPECTROGRAPHIC CALIBRATION 6-223

TABLE 6I-1. WAVELENGTH STANDARDS FOR THE VACUUM ULTRAVIOLET\* (Continued)

Wavelength, Å	Inten- sity	Spec- trum	Esti- mated relative error (±mÅ)	Wavelength, Å	Inten- sity	Spec- trum	Esti- mated relative error (±mÅ)
1,649.932	10	Hg II	4	1,329.590	40	C I	1
1,640.474	80 <sup>d</sup>	He II	4	1,329.108	40	C I	2
1,640.342	100 <sup>d</sup>	He II	2	1,328.836 <sup>d</sup>	15	C I	10
1,630.180	2	Si I	3	1,327.927	10	N I	2
1,629.931	4	Si I	4	1,326.572	15	N I	4
1,629.830	4	N II	4	1,321.712	20	Hg II	3
1,629.366	4	Si I	4	1,319.684	30	N I	4
1,613.251	4	He II	4	1,319.003	20	N I	2
1,605.321	1	He II	3	1,316.287	1	N I	1
1,602.598	15	C I	3	1,311.365	20	C I	3
1,592.245	4	Si I	3	1,310.952	25	N I	1
1,589.607	2	Si I	3	1,310.548	25	N I	3
1,574.035	1	N II	3	1,309.278	3	Si II	5
1,561.433	20	C I	2	1,307.928	10	Hg II	3
1,561.339	5	C I	4	1,306.036	25	O I	3
1,560.687 <sup>d</sup>	15	C I	12	1,304.872	30	O I	5
1,560.301	2	C I	5	1,302.173	30	O I	1
1,504.474	5	Hg III	4	1,288.430	5	C I	3
1,494.673	60	N I	4	1,280.852 <sup>e</sup>	10	C I	1
1,492.824	30	N I	4	1,280.604 <sup>e</sup>	8	C I	3
1,492.624	80	N I	5	1,280.403 <sup>e</sup>	5	C I	4
1,485.600	8	Si II	2	1,280.340 <sup>e</sup>	15	C I	1
1,481.760	30	C I	3	1,280.140 <sup>e</sup>	8	C I	1
1,470.082	5	C I	3	1,279.897 <sup>e</sup>	10	C I	1
1,469.844	15	C I	4	1,279.230	8	C I	3
1,467.405	20	C I	3	1,277.727	20	C I	1
1,466.723	5	N I	4	1,277.551	50	C I	4
1,463.838	40	C	3	1,277.282	40	C I	1
1,463.346	40	C I	2	1,276.754	3	N II	1
1,459.034	20	C I	4	1,265.001	1	Si II	1
1,439.094	10	Si II	2	1,261.559 <sup>f</sup>	15	C I	1
1,411.948	30	N I	3	1,261.430 <sup>f</sup>	8	C I	4
1,393.322	1	Hg III	2	1,261.128 <sup>f</sup>	8	C I	1
1,364.165	8	C I	4	1,261.000 <sup>f</sup>	8	C I	1
1,361.267	8	Hg II	4	1,260.930 <sup>f</sup>	8	C I	2
1,357.140	5	C I	2	1,260.738 <sup>f</sup>	8	C I	1
1,355.598	2	O I	3	1,259.523	10	C I	3
1,354.292	8	C I	3	1,253.816	5	C I	1
1,350.074	4	Hg II	2	1,251.164	8	Si II	4
1,335.692	80	C II	5	1,250.586	4	Hg I	4
1,335.184	8	Hg	3	1,248.426	5	Si II	4
1,334.520	60	C II	5	1,246.738	1	Si II	3
1,331.737	20	Hg II	4	1,243.309	15	N I	4

TABLE 6I-1. WAVELENGTH STANDARDS FOR THE VACUUM ULTRAVIOLET\* (Continued)

Wavelength, Å	Inten- sity	Spec- trum	Esti- mated relative error (±mÅ)	Wavelength, Å	Inten- sity	Spec- trum	Esti- mated relative error (±mÅ)
1,243.179	20	N I	1	1,098.103	40	N I	5
1,229.172	1	N I	1	1,097.990	25	N I	4
1,228.790	10	N I	4	1,097.245	50	N I	4
1,228.410	5	N I	4	1,096.749	35	N I	4
1,225.372	10	N I	1	1,096.322	35	N I	2
1,225.028	15	N I	4	1,095.940	35	N I	3
1,215.662	100R <sup>b</sup>	II	5	1,085.707	50	N II	3
1,215.167	5	He II	5	1,085.546	3	N II	5
1,215.086	5	He II	4	1,085.442	3	N II	3
1,200.708 <sup>c</sup>	30	N I	2	1,084.970	2	He II	4
1,200.226 <sup>c</sup>	40	N I	1	1,084.910	2	He II	5
1,199.718 <sup>c</sup>	2	N I	4	1,084.579	30	N II	3
1,199.551 <sup>c</sup>	50	N I, C I	5	1,083.990	20	N II	4
1,194.496	5	Si I	1	1,070.821	0	N I	5
1,194.060	3	C I	3	1,069.984	30	N I	1
1,193.674	3	C I	3	1,068.476	35	N I	4
1,193.388 <sup>d</sup>	3	C I	8	1,067.607	35	N I	4
1,193.243	15	C I	2	1,041.688	1	O I	4
1,193.013	15	C I	4	1,040.941	15	O I	4
1,189.628	5	N I	4	1,039.233	20	O I	4
1,189.244	3	N I	3	1,037.627	0	O	3
1,188.972	5	N I	1	1,037.020	0	C II	1
1,177.694	15	N I	3	1,028.162	8	O I	3
1,176.626	3	N I	5	1,027.433	20	O I	3
1,176.508	15	N I	1	1,025.728	60	H	3
1,170.276	1	N I	3	1,025.208	2 <sup>i</sup>	He II	5
1,169.692	1	N I	1	990.805 <sup>A</sup>	2	O I	4
1,168.537	20	N I	4	990.210 <sup>A</sup>	8	O I	4
1,168.334	8	N I	4	990.132 <sup>A</sup>	1	O I	4
1,167.450	25	N I	4	988.776 <sup>A</sup>	15	O I	4
1,164.322	8	N I	3	988.661 <sup>A,d</sup>	2	O I	4
1,163.884	12	N I	4	977.967	1	O I	4
1,158.138	1	C I	5	964.626	1	N I	4
1,158.030	8	C I	4	963.991	5	N I	4
1,152.149	2	O I	5	953.658	15	N I	4
1,134.988	25	N I	4	953.415	15	N I	3
1,134.426	25	N I	4	952.522	4	N I	4
1,134.176	20	N I	4	952.414	8	O I	4
1,101.293	40	N I	5	952.304	8	N I	4
1,100.362	30	N I	4	950.114	0	O I	4
1,099.259	40	Hg II	3	949.742	25	H	4
1,099.153	25	N I	5	910.279	0	N I	5
1,098.264	40	N I	5	909.692	0	N I	5

WAVELENGTHS FOR SPECTROGRAPHIC CALIBRATION 6-225

TABLE 61-1. WAVELENGTH STANDARDS FOR THE VACUUM ULTRAVIOLET\* (Continued)

Wavelength, Å	Inten- sity	Spec- trum	Esti- mated relative error (±mÅ)	Wavelength, Å	Inten- sity	Spec- trum	Esti- mated relative error (±mÅ)
906.722	1	N I	2	893.079	0	Hg II	2
906.426	15	N I	4	888.363	0	N I	2
906.202	10	N I	3	888.019	0	N I	4
905.829	5	N I	4	875.092	5	N I	5

\* *J. Opt. Soc. Am.* **45**, 10 (1955).  
 \* Identification: A. Fowler, *Proc. Roy. Soc. (London)*, ser. A, **123**, 422 (1929); J. C. Boyce and H. A. Robinson, *J. Opt. Soc. Am.* **26**, 133 (1936).  
 † Self-reversed resonance line.  
 ‡ Resolved  $2p^2 \ ^1P - 3s \ ^1P^0$  multiplet.  
 § Blended line.  
 ¶ Completely resolved  $2p^2 \ ^1P - 4s \ ^1P^0$  multiplet.  
 // Completely resolved  $2p^2 \ ^1P - 3d \ ^1P^0$  multiplet.  
 ° Resolved  $2p^3 \ ^1S^0 - 3s \ ^1P$  multiplet.  
 ^  $2p^3 \ ^1P - 3s \ ^1D^0$  multiplet.  
 † Diffuse line.

TABLE 6I-2. PROPOSED INTERNATIONAL WAVELENGTH STANDARDS  
IN THE VACUUM ULTRAVIOLET

Wave-length, Å, this research	Spectrum	Wave-length, Å, More and Rieke <sup>a</sup>	Wave-length, Å, Boyce and Rieke <sup>b</sup>	Wave-length, Å, Weber and Watson <sup>c</sup>	Wave-length, Å, other observers	Wave-length, Å, mean value
1,930.902	C I	.....	0.900	0.889	.....	1,930.897
1,745.246	N I	.....	0.246	0.255	.....	1,745.249
1,742.724	N I	.....	0.734	0.733	.....	1,742.730
1,740.327	N II	.....	.....	0.320	0.315 <sup>d</sup>	1,740.321
1,658.117	C I	.....	0.126	0.127	.....	1,658.123
1,657.899	C I	0.909	.....	.....	0.891 <sup>e</sup>	1,657.900
1,657.374	C I	.....	0.380	0.381	.....	1,657.378
1,657.001	C I	.....	0.005	.....	6.998 <sup>e</sup>	1,657.001
1,656.259	C I	0.266	.....	.....	0.255 <sup>e</sup>	1,656.260
1,560.301	C I	0.308	0.316	.....	.....	1,560.308
1,494.673	N I	0.672	0.669	0.668	.....	1,494.670
1,492.624	N I	.....	0.630	0.634	.....	1,492.630
1,481.760	C I	0.771	.....	.....	0.750 <sup>f</sup>	1,481.760
1,335.692	C II	0.700	.....	.....	0.684 <sup>g</sup>	1,335.692
1,329.590	C I	0.587	.....	.....	0.583 <sup>h</sup>	1,329.587
1,329.108	C I	0.102	0.101	.....	.....	1,329.104
1,277.282	C I	.....	0.274	.....	0.280 <sup>h</sup>	1,277.279
1,261.559	C I	.....	0.560	.....	0.565 <sup>h</sup>	1,261.561
1,200.708	N I	0.719	0.706	0.693	.....	1,200.708
1,200.226	N I	0.217	0.220	0.215	.....	1,200.219
1,199.551	N I	0.552	0.547	0.557	.....	1,199.552
1,177.694	N I	0.701	.....	0.677	.....	1,177.691
1,176.508	N I	0.506	.....	0.498	.....	1,176.504
1,167.450	N I	0.442	.....	0.454	.....	1,167.449
1,134.988	N I	0.977	0.980	0.980	.....	1,134.981
1,134.426	N I	.....	0.419	0.416	.....	1,134.420
1,134.176	N I	.....	0.171	0.169	.....	1,134.172
1,085.546	N II	.....	0.546	0.546	.....	1,085.546
1,084.579	N II	0.584	0.579	0.582	.....	1,084.580
1,083.990	N II	.....	0.991	0.990	.....	1,083.990
990.805	C I	0.790	0.797	.....	.....	990.797
990.210	C I	0.198	0.213	.....	.....	990.207

- <sup>a</sup> K. R. More and C. A. Rieke, *Phys. Rev.* **50**, 1054 (1936).  
<sup>b</sup> J. C. Boyce and C. A. Rieke, *Phys. Rev.* **47**, 653 (1935).  
<sup>c</sup> R. L. Weber and W. W. Watson, *J. Opt. Soc. Am.* **26**, 307 (1936).  
<sup>d</sup> A. Fowler, *Proc. Roy. Soc. (London)*, ser. A, **123**, 422 (1929).  
<sup>e</sup> A. G. Shenstone, *Phys. Rev.* **72**, 411 (1947).  
<sup>f</sup> E. Ekefors, *Z. Physik* **63**, 437 (1930).  
<sup>g</sup> B. Edlén, *Z. Physik* **98**, 561 (1936); *Nature* **159**, 129 (1947).  
<sup>h</sup> F. Paschen and G. Kruger, *Ann. Phys.* **7**, 1 (1930).

WAVELENGTHS FOR SPECTROGRAPHIC CALIBRATION 6-227

TABLE 6I-3. INFRARED STANDARD WAVELENGTHS

Wave-length, $\mu\text{m}$	State	Description	Substance	Ref.
0.54607	Emission	AH-4 lamp	Mercury	9
0.57696	Emission	AH-4 lamp	Mercury	9
0.57907	Emission	AH-4 lamp	Mercury	9
1.01398	Emission	AH-4 lamp	Mercury	9
1.12866	Emission	AH-4 lamp	Mercury	9
1.140	Liquid	.....	Benzene	6
1.35703	Emission	AH-4 lamp	Mercury	9
1.36728	Emission	AH-4 lamp	Mercury	9
1.39506	Emission	AH-4 lamp	Mercury	9
1.52452	Emission	AH-4 lamp	Mercury	9
1.6606	Liquid	0.5-mm cell	1,2,4-Trichlorobenzene	9
1.671	Liquid	.....	Benzene	6
1.69202	Emission	AH-4 lamp	Mercury	9
1.69419	Emission	AH-4 lamp	Mercury	9
1.70727	Emission	AH-4 lamp	Mercury	9
1.71090	Emission	AH-4 lamp	Mercury	9
1.81307	Emission	AH-4 lamp	Mercury	9
1.97009	Emission	AH-4 lamp	Mercury	9
2.008	Gas	.....	Carbon dioxide	9
2.150	Liquid	.....	Benzene	6
2.1526	Liquid	0.5-mm cell	1,2,4-Trichlorobenzene	9
2.22	Liquid	.....	Carbon disulfide	9
2.24929	Emission	AH-4 lamp	Mercury	9
2.3126	Liquid	0.5-mm cell	1,2,4-Trichlorobenzene	9
2.32542	Emission	AH-4 lamp	Mercury	9
2.37	Solid	25- $\mu\text{m}$ film	Polystyrene	Wright
2.4030	Liquid	0.5-mm cell	1,2,4-Trichlorobenzene	9
2.4374	Liquid	0.5-mm cell	1,2,4-Trichlorobenzene	9
2.439	Gas	.....	Carbon oxysulfide central min	8
2.464	Liquid	.....	Benzene	5
2.4944	Liquid	0.5-mm cell	1,2,4-Trichlorobenzene	9
2.5434	Liquid	0.5-mm cell	1,2,4-Trichlorobenzene	9
2.688	Gas	.....	Carbon dioxide	Barker and Wu
2.7144	Vapor	5.0-cm cell	Methanol	9
2.765	Gas	.....	Carbon dioxide	Barker and Wu
2.79	Solid	.....	Lithium fluoride	9
2.996	Gas	200-mm 5.0-cm cell	Ammonia-zero branch	2
3.2204	Solid	25- $\mu\text{m}$ film	Polystyrene	9
3.230	Gas	.....	Carbon oxysulfide central min	8
3.2432	Solid	25- $\mu\text{m}$ film	Polystyrene	9
3.2666	Solid	25- $\mu\text{m}$ film	Polystyrene	9
3.3033	Solid	25- $\mu\text{m}$ film	Polystyrene	9
3.3101	Solid	25- $\mu\text{m}$ film	Polystyrene	9

TABLE 61-3. INFRARED STANDARD WAVELENGTHS (Continued)

Wave-length, $\mu$	State	Description	Substance	Ref.
3.320	Gas	.....	Methane-zero branch	7
3.3293	Gas	5.0-cm cell	Methane	9
3.4188	Solid	25- $\mu$ m film	Polystyrene	9
3.426	Gas	.....	Carbon oxysulfide central min	8
3.465	Gas	.....	Hydrogen chloride central min	
3.5078	Solid	25- $\mu$ m film	Polystyrene	9
4.258	Gas	Atmospheric	Carbon dioxide	9
4.613	Vapor	.....	Carbon disulfide central min	5
4.866	Vapor	5.0-cm cell	Methanol	9
4.875	Gas	.....	Carbon oxysulfide central min	8
5.138	Solid	50- $\mu$ m film	Polystyrene	9
5.284	Gas	.....	Carbon oxysulfide central min	8
5.292	Gas	.....	Ethylene central min	5
5.549	Solid	50- $\mu$ m film	Polystyrene	9
5.847	Gas	.....	Carbon oxysulfide central min	8
6.154	Gas	200 mm 5.0-cm cell	Ammonia-zero branch	2
6.238	Solid	50- $\mu$ m film	Polystyrene	9
6.692	Solid	50- $\mu$ m film	Polystyrene	9
6.753	Liquid	.....	Benzene	S. Silverman
6.925	Gas	.....	Ethylene-zero branch	5
7.268	Liquid	0.05-mm cell	Methylcyclohexane	9
7.681	Gas	.....	Methane-zero branch	3
8.241	Gas	200-mm 5.0-cm cell	Ammonia	2
8.362	Gas	200-mm 5.0-cm cell	Ammonia	2
8.490	Gas	200-mm 5.0-cm cell	Ammonia	2
8.623	Gas	200-mm 5.0-cm cell	Ammonia	2
8.762	Gas	200-mm 5.0-cm cell	Ammonia	2
9.057	Gas	200-mm 5.0-cm cell	Ammonia	2
9.216	Gas	200-mm 5.0-cm cell	Ammonia	2
9.295	Gas	200-mm 5.0-cm cell	Ammonia	2
9.378	Gas	200-mm 5.0-cm cell	Ammonia	2
9.548	Gas	.....	Carbon oxysulfide central min	8
9.608	Vapor	.....	Methyl chloride	4
9.672	Vapor	5-cm cell	Methanol	9
9.673	Gas	.....	Ammonia	Wright
9.724	Solid	50- $\mu$ m film	Polystyrene	9
9.807	Vapor	.....	Methyl chloride	4
9.85	Gas	.....	Ammonia	Wright

WAVELENGTHS OR SPECTROGRAPHIC CALIBRATION 6-229  
 TABLE 6I-3. INFRARED STANDARD WAVELENGTHS (Continued)

Wave-length, $\mu\text{m}$	State	Description	Substance	Ref.
10.073	Gas	200-mm 5.0-cm cell	Ammonia	2
10.53	Gas	.....	Ethylene-zero branch	5
11.008	Gas	200-mm 5.0-cm cell	Ammonia	2
11.035	Solid	50- $\mu\text{m}$ film	Polystyrene	9
11.26	Gas	200-mm 5.0-cm cell	Ammonia	<i>J. Opt. Soc. Am.</i>
11.475	Liquid	0.05-mm cell	Methylcyclohexane	9
11.793	Gas	200-mm 5.0-cm cell	Ammonia	2
11.862	Liquid	0.05-mm cell	Methylcyclohexane	9
12.075	Gas	200-mm 5.0-cm cell	Ammonia	2
12.381	Gas	200-mm 5.0-cm cell	Ammonia	2
12.732	Gas	.....	Acetylene	1
12.809	Gas	.....	Acetylene	1
12.885	Gas	.....	Acetylene	1
12.961	Gas	.....	Acetylene	1
12.99	Gas	.....	Ammonia	1
13.69	Gas	.....	Acetylene	Wright
13.883	Gas	Atmospheric	Carbon dioxide	1
14.29*	Solid	50- $\mu\text{m}$ film	Polystyrene	9
14.42	Liquid	.....	Toluene 1% in carbon disulfide	9
14.98	Gas	Atmospheric	Carbon dioxide	9
15.48	Liquid	0.05 mm (1:4 CS <sub>2</sub> )	Unknown in technical grade of 1,2,4-trichlorobenzene	9
17.40*	Liquid	0.025-mm cell	1,2,4-Trichlorobenzene	9
18.16	Liquid	0.025-mm cell	1,2,4-Trichlorobenzene	9
20.56	Liquid	0.05-mm cell	1,2,4-Trichlorobenzene (sat. sol. in CS <sub>2</sub> )	9
21.52	Liquid	0.05-mm cell	Toluene	9
21.80	Liquid	0.025-mm cell	1,2,4-Trichlorobenzene	9
22.76*	Liquid	0.025-mm cell	1,2,4-Trichlorobenzene	9
23.85	Vapor	Atmospheric	Water	9

\* Broad bands.

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