

The Thermal Conductivities of Eight Common Gases between 80° and 380°K

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was determined experimentally by us and is in agreement with the careful work of Milverton.¹⁷ Furthermore, it corresponds to a reflectivity of 96 percent, which is in reasonable agreement with optical measurements for the wave-lengths of maximum intensity at 273.1°K (~10 microns). While the potential lead correction is less certain its full magnitude at 273.1° is only 0.51 percent.

From the standpoint of absolute accuracy the advantage of our method is that the energy and temperature measurements are made directly on the effective length of the cell wire, with a correction of only 0.5 percent necessary for the cell leads. The use of compensating cells assumes cancellation of end effects in the two cells amounting to 5 or 10 percent of the heat produced in the effective length of the wire. In the thick wire cell as much as 50 percent of the heat flows from the ends of the cell, and is evaluated

by means of an auxiliary determination of the thermal conductivity of the wire. It would seem that the possibility of serious systematic error is least with the potential lead method.

The temperature coefficient of the thermal conductivity of air at 273.1°K has been much in dispute.¹⁷ The value obtained in this research is 0.00291. A tabulation of values obtained, by various workers, is shown in Table IX.

ACCOMMODATION COEFFICIENTS

Accommodation coefficients may be computed from the slope of the $(1/K_a)$ versus $(1/p)$ plots. A theoretical treatment of this will be reserved for a subsequent paper from this laboratory. The paper will include tabulations of accommodation coefficients on bright platinum for air, from the data of this research, and for nine other gases, from data obtained by Johnston and Grilly.

The Thermal Conductivities of Eight Common Gases between 80° and 380°K

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(Received December 26, 1945)

Thermal conductivities of O₂, N₂, CO, NO, H₂, He, N₂O, CO₂, and CH₄ have been measured between 80°K and 380°K, with the potential lead type of hot wire cell developed by Taylor and Johnston. Results—which have a precision generally better than 0.1 of one percent and are believed to be accurate to ± 0.5 of one percent—are tabulated for the eight gases. Comparisons with the results of other investigators are also shown in tabular form.

WE have measured thermal conductivities of oxygen, nitric oxide, hydrogen, carbon monoxide, carbon dioxide, nitrous oxide, methane, and helium over the temperature range 80°K (or temperatures at which the vapor pressures amounted to about 10 cm of Hg) to 380°K. Measurements were made at intervals of about 15°.

APPARATUS AND METHOD

Apparatus and method have been described in an earlier paper by Taylor and Johnston.¹ The following slight modifications were made for this work:

¹ W. J. Taylor and H. L. Johnston, *J. Chem. Phys.* **14**, 219 (1946).

(1) Thermocouple *C*, used by Taylor and Johnston, was replaced by two new copper-constantan thermocouples, designated couples *V* and *W*. These were calibrated at 90°K (b.p. O₂), 195°K (s.p. CO₂), 234°K (f.p. Hg), 273°K (m.p. H₂O), 305°K (t.p. Na₂SO₄), and 373°K (b.p. H₂O) by the method suggested in the Symposium on Temperature.² The two thermocouples were used simultaneously to measure the bath temperature. They always agreed with each other to within 0.1 microvolt, which is within 0.005°, throughout the course of the measurements.

² *Temperature, Its Measurement and Control in Science and Industry*, American Institute of Physics (Reinhold Publishing Corporation, New York, 1941).

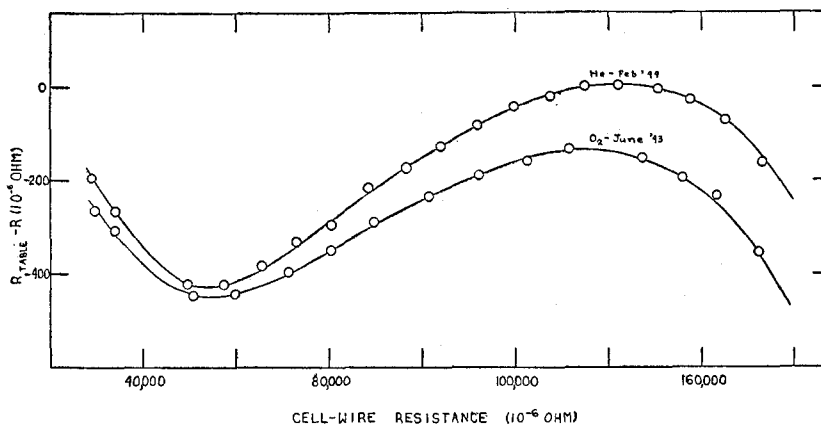


FIG. 1. Shift of cell wire calibration with time.

(2) The multiple junction thermocouple used in thermostating the cryostat bath was replaced by a resistance thermometer, which gave steadier thermostating.

(3) The float system for controlling the level of liquid air in the cryostat was replaced by an air thermometer, which actuates a relay by making and breaking contacts with the mercury in a U tube with which it is joined.

(4) Two sets of high capacity batteries were substituted for the one set used by Taylor and Johnston to supply energy to the cell wire. One set was used for the higher heating current (0.5 ampere) and was kept stabilized at this discharge rate during the full day when measurements were in progress, while the other set was used and

stabilized for the lower current (0.1 ampere) used in calibrating the wire.

(5) Kerosene was substituted, as thermostat bath liquid, for the mineral oil employed by Taylor and Johnston. Because of its lower viscosity, kerosene provides more uniform thermostating.

To eliminate "temperature jump" apparent conductivities were always measured at three different pressures. These were usually taken close to one, five, and ten cm of Hg, respectively.

Calibrations of the cell wire were made simultaneous with the thermal conductivity measurements, in the manner described by Taylor and Johnston. During the period of our work the resistance of the cell wire decreased slowly but steadily, indicative of a continuing relief of strain. Figure 1 shows this effect over the eight months period that encompassed our measurements. The radius of the circles is equivalent to approximately 0.02° . New calibration curves were constructed as often as necessary, from the calibration data taken simultaneous with the conductivity measurements.

PREPARATION OF GASES

Pure gases were prepared by the methods outlined below. Where reference is made to fractional distillation the procedure followed was the efficient "bubbler" method described by Johnston and GIAUQUE.³ Only the middle third of the liquid was retained in each of the several cycles.

TABLE I. Thermal conductivity of oxygen.

Date	T, °K	$K \times 10^6$	% dev. from curve
6/19/43	86.53	1.851	0.00
6/19/43	94.55	2.035	0.00
11/4/42	98.02	2.113	-0.02
6/20/43	127.22	2.774	-0.08
10/28/42	130.99	2.861	0.00
6/20/43	144.56	3.166	0.00
10/28/42	151.24	3.316	+0.06
6/20/43	167.28	3.676	+0.22
6/20/43	185.17	4.051	-0.22
6/17/43	205.38	4.488	0.00
6/17/43	229.36	4.981	+0.01
6/17/43	250.87	5.408	-0.01
6/17/43	272.07	5.819	0.00
6/17/43	290.90	6.175	-0.01
6/22/43	323.86	6.828	+0.02
6/22/43	341.99	7.201	-0.10
6/22/43	357.63	7.547	+0.05
6/22/43	376.30	7.956	+0.05
Average deviation from smooth curve			$\pm 0.047\%$

³ H. L. Johnston and W. F. GIAUQUE, J. Am. Chem. Soc. 51, 3194 (1929).

TABLE II. Thermal conductivity of nitric oxide.

Date	T, °K	K × 10 ⁶	% dev. from curve
7/1/43	129.86	2.786	+0.04
7/1/43	147.82	3.165	-0.06
7/1/43	174.57	3.719	+0.01
7/1/43	191.51	4.077	+0.13
6/26/43	208.40	4.420	+0.02
6/26/43	227.76	4.793	-0.04
6/26/43	245.51	5.139	-0.04
3/8/44	266.20	5.544	+0.04
3/8/44	283.03	5.860	-0.08
3/8/44	298.80	6.168	+0.02
3/8/44	313.38	6.444	+0.01
3/8/44	330.56	6.752	-0.21
3/8/44	346.25	7.056	-0.07
3/8/44	361.97	7.361	+0.08
3/8/44	376.77	7.630	0.00

Average deviation from smooth curve ±0.057%

TABLE III. Thermal conductivity of hydrogen.

Date	T, °K	K × 10 ⁶	% dev. from curve
11/5/43	84.70	13.90	-0.57
11/5/43	93.99	15.41	+0.33
12/23/43	125.60	19.91	-0.35
12/23/43	142.23	22.46	+0.22
12/23/43	158.70	24.89	+0.36
11/2/43	175.95	27.19	-0.22
11/2/43	192.28	29.38	-0.67
3/31/44	200.40	30.68	-0.03
11/2/43	207.66	31.62	-0.15
3/31/44	218.18	33.09	-0.02
3/31/44	236.56	35.56	+0.02
3/31/44	254.38	37.68	+0.20
3/31/44	274.02	39.75	+0.01
11/7/43	277.69	40.05	-0.17
11/7/43	293.28	41.64	-0.03
11/9/43	324.28	44.53	+0.11
11/9/43	341.27	45.97	-0.15
11/9/43	357.31	47.51	-0.04
11/9/43	374.25	49.10	+0.04

Average deviation from smooth curve ±0.194%

Oxygen: Pure oxygen was obtained by passing commercial oxygen (99.5 percent) over potassium hydroxide, hot copper oxide, potassium hydroxide, and phosphorous pentoxide in turn. This was followed by fractional distillation.

Nitric Oxide: Nitric oxide was prepared and purified by the method of Johnston and Giauque.³

Hydrogen: Hydrogen was prepared by the electrolysis of potassium hydroxide solution. The product was passed over platinized asbestos followed by phosphorus pentoxide and was passed through a liquid air trap as the final step. A spectroscopic analysis by P. G. Wilkinson⁴

⁴ P. G. Wilkinson, Ph.D. Dissertation, The Ohio State University, 1941.

TABLE IV. Thermal conductivity of carbon dioxide.

Date	T, °K	K × 10 ⁶	% dev. from curve
11/15/43	186.38	2.073	+0.02
11/15/43	200.86	2.285	-0.02
11/15/43	216.49	2.527	-0.03
11/16/43	230.68	2.752	+0.01
11/16/43	245.57	3.002	-0.02
11/16/43	259.60	3.245	0.00
11/16/43	274.22	3.505	0.00
11/16/43	287.75	3.754	-0.02
11/16/43	302.38	4.031	+0.05
11/16/43	311.24	4.199	0.00
11/13/43	333.87	4.649	0.00
11/13/43	347.32	4.932	-0.04
11/13/43	363.36	5.273	0.00
11/13/43	379.49	5.614	+0.09

Average deviation from smooth curve ±0.020%

TABLE V. Thermal conductivity of nitrous oxide.

Date	T, °K	K × 10 ⁶	% dev. from curve
12/18/43	190.25	2.175	0.00
12/18/43	206.88	2.438	-0.04
12/18/43	225.80	2.760	+0.04
12/18/43	232.06	2.870	0.00
12/18/43	249.05	3.172	-0.04
12/18/43	262.40	3.421	+0.10
12/19/43	275.60	3.669	+0.03
12/19/43	290.59	3.958	0.00
12/19/43	303.43	4.217	0.00
2/21/44	317.55	4.511	+0.03
2/21/44	332.42	4.829	+0.10
2/21/44	348.08	5.150	-0.20
2/21/44	364.11	5.505	-0.12
2/21/44	378.45	5.836	+0.05

Average deviation from smooth curve ±0.053%

indicated that the mole percent of oxygen impurity was less than 0.01 percent.

Carbon Dioxide: Carbon dioxide was prepared by thermally decomposing sodium bicarbonate as described by Wilkinson,⁴ who showed the oxygen content of gas so prepared to be less than 0.001 percent.

Carbon Monoxide: Carbon monoxide was prepared by dropping formic acid into concentrated sulfuric acid. The product was passed through a 50 percent potassium hydroxide solution, dried over phosphorus pentoxide, and fractionally distilled. Wilkinson⁴ obtained gas with less than 0.001-mole percent impurity, by this method.

Nitrous Oxide: Cylinder nitrous oxide ("Puritan" hospital quality) was passed over phosphorous pentoxide, and fractionally distilled. According to Quinn and Wernimont⁵ and Blue

⁵ E. L. Quinn and G. Wernimont, J. Am. Chem. Soc. **51**, 2004 (1929); **52**, 2725 (1930).

TABLE VI. Thermal conductivity of carbon monoxide.

Date	T, °K	K × 10 ⁵	% dev. from curve
12/20/43	87.41	1.802	-0.02
12/20/43	97.87	2.039	+0.02
12/21/43	130.06	2.717	-0.50
12/21/43	145.31	3.054	-0.33
12/21/43	155.07	3.261	+0.07
11/19/43	176.06	3.682	-0.16
11/19/43	192.28	4.013	0.00
11/19/43	207.36	4.308	-0.03
11/19/43	222.62	4.604	+0.03
11/19/43	237.21	4.876	+0.01
11/19/43	253.12	5.162	-0.03
11/19/43	267.08	5.412	-0.03
11/20/43	282.15	5.683	0.00
11/20/43	296.90	5.950	+0.12
11/20/43	312.00	6.210	0.00
11/22/43	328.89	6.502	-0.09
11/22/43	344.66	6.788	0.00
2/23/44	357.58	7.021	0.00
2/23/44	376.96	7.372	0.00

Average deviation from smooth curve ±0.076%

TABLE VII. Thermal conductivity of methane.

Date	T, °K	K × 10 ⁵	% dev. from curve
1/13/44	96.76	2.451	0.00
1/10/44	125.35	3.195	-0.33
1/10/44	140.49	3.608	0.00
1/10/44	155.29	4.005	+0.05
1/10/44	169.93	4.406	+0.25
1/12/44	185.41	4.805	-0.16
1/12/44	201.24	5.245	-0.11
1/12/44	216.69	5.684	0.00
1/12/44	231.71	6.117	+0.08
1/12/44	246.86	6.554	+0.04
1/12/44	262.85	7.025	0.00
1/12/44	278.72	7.510	0.00
1/12/44	294.49	8.026	+0.25
1/14/44	324.00	8.986	-0.25
1/14/44	338.60	9.539	+0.02
1/14/44	353.96	10.146	+0.10
1/14/44	368.33	10.729	0.00
1/14/44	383.57	11.376	+0.01

Average deviation from smooth curve ±0.092%

and Giauque⁶ the impurities in this grade of commercial nitrous oxide are nitrogen, oxygen, and water. These should all be easily removed by fractional distillation.

Methane. Methane was obtained from natural gas⁷ by passing the latter through a trap at

⁶ R. W. Blue and W. F. Giauque, J. Am. Chem. Soc. **57**, 992 (1935).

⁷ The following analysis was furnished us by Mr. A. M. Hutchison of the Ohio Fuel Gas Company, as typical of the natural gas in the Columbus mains: carbon dioxide, 0.5 percent; oxygen, 0.0 percent; hydrogen, 1.3 percent; carbon monoxide, 0.6 percent; nitrogen, 5.0 percent; illuminants, 0.0 percent; methane, 80.6 percent; higher hydrocarbons, 12 percent.

193°K, followed by two consecutive tubes of charcoal⁸ at 193°K. After this the product was fractionally distilled. Storch and Golden⁹ used this method on natural gas of similar composition. In their experience they found the following concentration of impurities after the passage

TABLE VIII. Thermal conductivity of helium.

Date	T, °K	K × 10 ⁵	% dev. from curve
2/1/44	82.79	15.72	0.00
2/1/44	92.71	16.96	+0.15
2/3/44	122.67	19.91	-0.02
2/3/44	137.90	21.41	-0.42
2/3/44	154.30	23.13	-0.16
2/3/44	169.89	24.72	+0.05
2/3/44	184.32	26.09	0.00
2/4/44	200.24	27.50	-0.32
2/4/44	216.89	29.12	+0.04
2/4/44	231.74	30.42	-0.04
2/4/44	248.42	31.87	+0.02
2/4/44	264.36	33.19	-0.03
2/4/44	280.53	34.50	0.00
2/4/44	296.18	35.74	+0.08
2/18/44	328.79	38.05	-0.04
2/18/44	344.43	39.12	+0.06
1/31/44	359.59	39.99	-0.07
1/31/44	375.68	40.94	0.00

Average deviation from smooth curve ±0.083%

TABLE IX. Smoothed thermal conductivities ($K \times 10^5$).

T, °K	O ₂	CO	He	H ₂	CH ₄	NO	CO ₂	N ₂ O
80	1.701	1.652	15.34	13.31				
90	1.930	1.870	16.43	14.78	2.272			
100	2.159	2.086	17.51	16.25	2.536			
110	2.387	2.302	18.58	17.71	2.800			
120	2.614	2.516	19.64	19.17	3.065	2.580		
130	2.840	2.730	20.68	20.63	3.331	2.792		
140	3.064	2.942	21.71	22.09	3.595	3.003		
150	3.287	3.153	22.73	23.54	3.860	3.214		
160	3.508	3.361	23.73	24.98	4.128	3.423		
170	3.728	3.565	24.72	26.42	4.396	3.631		
180	3.946	3.768	25.68	27.84	4.667	3.838	1.984	2.021
190	4.162	3.968	26.63	29.25	4.940	4.042	2.126	2.173
200	4.375	4.166	27.56	30.64	5.216	4.245	2.272	2.330
210	4.584	4.361	28.49	32.00	5.496	4.445	2.424	2.493
220	4.790	4.553	29.39	33.33	5.778	4.643	2.580	2.661
230	4.993	4.741	30.28	34.64	6.063	4.840	2.741	2.823
240	5.194	4.926	31.15	35.89	6.351	5.035	2.907	3.011
250	5.392	5.107	32.00	37.09	6.643	5.229	3.077	3.192
260	5.586	5.286	32.83	38.23	6.940	5.423	3.251	3.377
270	5.780	5.465	33.65	39.32	7.242	5.615	3.429	3.564
280	5.970	5.644	34.45	40.35	7.549	5.807	3.611	3.755
290	6.159	5.821	35.23	41.33	7.862	5.999	3.796	3.949
300	6.350	5.998	36.00	42.27	8.186	6.189	3.984	4.149
310	6.547	6.175	36.74	43.19	8.518	6.379	4.175	4.352
320	6.748	6.351	37.46	44.11	8.862	6.568	4.371	4.562
330	6.954	6.528	38.15	45.02	9.219	6.756	4.571	4.775
340	7.164	6.705	38.81	45.94	9.590	6.944	4.777	4.991
350	7.378	6.884	39.44	46.85	9.978	7.131	4.988	5.206
360	7.594	7.065	40.05	47.77	10.372	7.318	5.202	5.425
370	7.812	7.246	40.62	48.69	10.797	7.504	5.416	5.644
380	8.033	7.427	41.17	49.60	11.220	7.690	5.630	5.861
273.1	5.839	5.521	33.90	39.65	7.336	5.674	3.485	3.623
293.1	6.218	5.876	35.48	41.64	7.962	6.057	3.854	4.011
298.1	6.314	5.964	35.86	42.10	8.123	6.153	3.948	4.110

⁸ The charcoal was baked under vacuum at 450°C for forty hours and was maintained at 193°K while the gas was passed through.

⁹ H. H. Storch and P. L. Golden, J. Am. Chem. Soc. **54**, 4662 (1932).

TABLE X. Comparisons of our own results on thermal conductivities at 273.1°K with those reported by other observers.

Gas	$K \times 10^5$	% dev. from J and G	Method*	Author	Year	Gas	$K \times 10^5$	% dev. from J and G	Method*	Author	Year
O ₂	5.839		$P L$	This research	1944	H ₂	39.65		$P L$	This research	1944
	5.89	+0.9	C	Northdurft ^a	1937		41.82	+5.4	C	Archer ^j	1938
	5.90	+1.1	C	Dickins ^b	1934		42.45	+7.4	C	Northdurft ^a	1937
	5.83	-0.2	$T W$	Kannuluik and Martin ^c	1934		42.69	+7.5	C	Gregory ^k	1935
	5.89	+0.9	C	Gregory and Marshall ^d	1928		41.70	+5.1	C	Dickins ^b	1934
	5.768	-1.2	$P L$	Weber ^e	1917		41.3	+4.0	$T W$	Kannuluik and Martin ^c	1934
	(5.839)	0.0	C	Eucken ^f	1911		40.62	+2.5	C	Hercus and Laby ^l	1922
	Av. +0.0						42.38	+6.8	$P L^{***}$	Weber ^{ma}	1927
NO	5.674		$P L$	This research	1944		40.43	+1.9	C^{**}	Gregory and Archer ^b	1926
	5.680	+0.1	C	Eucken ^s	1913		41.75	+5.3	$P L$	Schneider ⁿ	1926
CO	5.521		$P L$	This research	1944		41.65	+5.0	$P L^{***}$	Weber ^e	1917
	5.58	+1.0	C	Dickins ^b	1934		40.8	+2.7	C	Eucken ^s	1913
	5.37	-3.0	$T W$	Kannuluik and Martin ^c	1934		40.6	+2.5	C	Eucken ^f	1911
	5.633	+2.0	C	Gregory and Archer ^b	1928		Av. +4.4				
	5.557	+0.6	C	Eucken ^s	1913	CO ₂	3.485		$P L$	This research	1944
CH ₄	7.336		$P L$	This research	1944		3.47	-0.4	C	Archer ^j	1935
	7.21	-1.7	C	Dickins and Mann ⁱ	1931		3.51	+0.7	C	Dickins ^b	1934
	7.200	-1.8	$P L$	Weber ^e	1917		3.43	-1.5	$T W$	Kannuluik and Martin ^c	1934
	7.319	-0.2	C	Eucken ^s	1913		3.604	+3.4	C^{**}	Gregory and Marshall ^d	1927
	Av. -1.2						3.431	-1.5	$P L$	Weber ^{ma}	1927
He	33.90		$P L$	This research	1944		3.393	-2.7	$P L$	Weber ^e	1917
	35.10	+3.6	C	Dickins ^b	1934		3.442	-1.2	C	Eucken ^s	1913
	34.30	+1.2	$T W$	Kannuluik and Martin ^c	1934		3.421	-1.8	C	Eucken ^f	1911
	34.38	+1.4	$P L$	Weber ^e	1917	N ₂ O	3.623		$P L$	This research	1944
	34.21	+0.9	C	Eucken ^f	1911		3.64	+0.4	C	Dickins ^b	1934
	Av. +1.5						3.61	-0.3	$T W$	Kannuluik and Martin ^c	1934
							3.740	+3.2	C^{**}	Gregory and Archer ^b	1928
							3.530	-2.6	$P L$	Weber ^e	1917
							3.601	-0.6	C	Eucken ^s	1913

^a W. Northdurft, Ann. d. Physik **28**, 137 (1937).^b B. G. Dickins, Proc. Roy. Soc. (London) **A143**, 517 (1934).^c W. G. Kannuluik and L. H. Martin, Proc. Roy. Soc. (London) **A144**, 496 (1934).^d H. Gregory (Spencer-Gregory) and S. Marshall, Proc. Roy. Soc. (London) **A114**, 354 (1927); **A118**, 594 (1928).^e S. Weber, Ann. d. Physik **54**, 437 (1917).^f A. Eucken, Physik. Zeits. **12**, 1101 (1911).^g A. Eucken, Physik. Zeits. **14**, 324 (1913).^h H. Gregory (Spencer-Gregory) and C. T. Archer, Proc. Roy. Soc. (London) **A110**, 91 (1926).ⁱ B. G. Dickins and W. B. Mann, Proc. Roy. Soc. (London) **A134**, 77 (1931).^j C. T. Archer, Proc. Roy. Soc. (London) **A165**, 474 (1938).^k H. S. Gregory (Spencer-Gregory), Proc. Roy. Soc. (London) **A149**, 35 (1935).^l E. O. Hercus and T. H. Laby, Phil. Mag. **3**, 1061 (1927).^m S. Weber, Ann. d. Physik **82**, 479 (1927).ⁿ E. Schneider, Ann. d. Physik **80**, 215 (1926).^o C. T. Archer, Phil. Mag. **19**, 901 (1935).* Key to symbols: $P L$ Potential lead type of hot wire cell, C Compensating type of hot wire cell, $T W$ Thick wire cell.

** Temperature jump correction omitted or uncertain.

*** The hydrogen prepared by Weber was purified with charcoal at 80°K, which might have increased the parahydrogen content and thus the thermal conductivity.

through charcoal: oxygen, 0.2 percent; nitrogen, 2.0 percent; higher hydrocarbons, less than 0.05 percent. We believe that the conditions that pertained during our purification of methane were such as to yield at least as high purity at corresponding stages of the process. Our final product showed a triple point temperature of $90.63 \pm 0.04^\circ\text{K}$ which compares with the value $90.67 \pm 0.03^\circ\text{K}$ reported by Clusius and Weigant,¹⁰ for pure methane. It yielded a vapor pressure of 82.4 mm of Hg at 90.06°K . There is no data in the literature which can serve as a comparison for the vapor pressure. However the triple point comparison sets an upper limit of 0.15 percent for the mole fraction of impurity in our methane. The probable purity is considerably higher than this.

Helium: The helium was bought from the

¹⁰ K. Clusius and K. Weigand, Zeits. f. physik. Chemie **B46**, 1 (1940).

Linde Air Products Company as "spectroscopically pure." A spectroscopic analysis made on a portion of this gas, in connection with a previous investigation,¹¹ gave evidence of barely perceptible traces of argon and of neon. A repeat analysis, just before our thermal conductivity measurements were begun, yielded a similar result.

EXPERIMENTAL RESULTS

Experimental values of the thermal conductivities obtained for the several gases are presented in Tables I to VIII. The first column in each of these tables gives the dates on which the data were taken. The second column gives the average gas temperatures (cf. reference 1). The third column gives the thermal conductivities. These are obtained by extrapolating the re-

¹¹ H. L. Johnston and E. R. Grilly, J. Phys. Chem. **46**, 948 (1942).

TABLE XI. Comparisons of our own results on thermal conductivities with those reported by other investigators, at temperatures other than 273.1°K.

Gas	T, °K	$K \times 10^5$		% dev. from J and G	Author	Year
		This res.	Other res.			
CO ₂	285.1	3.703	3.69	-0.3	Archer ^a	1935
	309.7	4.169	3.99	-4.3		
	347.7	4.940	4.65	-5.8		
	373.6	5.493	5.12	-7.0		
	194.6	2.193	2.24	+2.5	Eucken ^b	1911
	373.0	5.480	5.08	-8.0		
	339.3	4.763	4.95	+4.0	Sherrat and Griffiths ^c	1939
	341.7	4.812	4.76	+1.1		
	342.1	4.821	4.80	-0.4		
	380.0	5.630	(5.62)	-0.2		
H ₂	94.6	15.46	15.3	-1.0	Spencer-Gregory and Dock ^d	1938
	96.6	15.75	15.5	-1.5		
	96.3*	15.71	15.6	-0.7		
	99.1	16.11	15.9	-1.3		
	99.3	16.15	16.0	-0.7		
	202.5	30.98	31.1	+0.3		
	209.4	31.92	31.7	-0.7		
	222.7	33.68	33.9	+0.7		
	224.5	33.92	34.5	+1.8		
	226.0	34.12	35.0	+2.6		
	280.4	40.39	42.2	+4.5		
	81.6	13.54	13.56	+0.2	Eucken ^e	1913
	81.5	13.53	13.63	+0.7	Eucken ^b	1911
	83.4	13.81	14.16	+2.5		
	90.4	14.84	15.16	+2.2		
	194.6	29.89	31.40	+5.0		
	373.0	48.96	51.16	+4.4		
O ₂	81.6	1.738	1.763	+1.5	Eucken ^b	1911
	90.4	1.939	1.991	+2.6		
	194.6	4.260	4.397	+2.7		
	373.0	7.878	7.608	-3.4		
CO	82.1	1.698	1.690	-0.5	Eucken ^e	1913
	91.6	1.905	1.890	-0.8		
	198.4	4.134	4.118	-0.4		
He	81.4	15.49	15.20	-2.0	Eucken ^e	1913
	80.3	15.39	14.92	-3.0	Eucken ^b	1911
	194.6	27.06	26.96	-0.4		
NO	373.0	40.78	40.82	+0.1	Eucken ^e	1913
	201.7	4.279	4.262	-0.4		
N ₂ O	201.3	2.351	2.776**	+18.1	Eucken ^e	1913
CH ₄	91.5	2.312	2.303	-0.4	Eucken ^e	1913
	197.5	5.147	5.061	-1.7		

^a See Table X, reference o.

^b See Table X, reference f.

^c G. G. Sherrat and E. Griffiths, Phil. Mag. 27, 68 (1939).

^d H. Spencer-Gregory and E. H. Dock, Phil. Mag. 25, 129 (1938).

^e See Table X, reference g.

* Probably intended for 97.3°.

** This abnormally large value must be due to the presence of air.

reciprocals of the apparent conductivities (cf. reference 1) against the reciprocals of pressure—for pressures of approximately one, five, and ten cm as referred to above—to $(1/p)$ equals zero. The fourth column lists the percentage deviations from smooth curves of the K 's *versus* temperature. Thermal conductivities are expressed

in the usual units, namely calories per second per centimeter per degree.

Smoothed values of the thermal conductivities, at even temperatures, are given in Table IX.

A good estimate of the precision of the measured conductivities is obtained by reference to the average percentage deviations from the respective smooth curves, in the plots of K *versus* temperature. Except for hydrogen, for which the average deviation amounts to almost 0.2 percent, these range from 0.02 percent (carbon dioxide) to 0.09 percent (methane). The absolute accuracy of the smoothed values should be about the same as obtained for air, by Taylor and Johnston¹—namely ± 0.5 percent. The careful error analysis made in that paper should be applicable here, with little modification.

COMPARISONS WITH THE RESULTS REPORTED BY OTHER INVESTIGATORS

Few measurements of thermal conductivity have been reported at temperatures other than the ice point. Comparisons with results reported by other investigators at 273.1°K are listed in Table X, for the percentage deviations from our own values, and with a reference to the method employed.

Comparisons at temperatures other than 273.1° are given in Table XI. Our own values in this table are from our smooth curves.

All of the values in Tables X and XI are obtained by methods which yield absolute values for the conductivity, except those of Eucken, who expressed his data relative to air at 273.1°K. For our purposes, his values have been shifted to correspond to $K_{273.1} = 5.839 \times 10^{-5}$ for oxygen.

ACCOMMODATION COEFFICIENTS

Accommodation coefficients may be computed from the reciprocal plots of apparent conductivity *versus* pressure. In a subsequent paper we will give accommodation coefficients on bright platinum for the several gases included in this research.