Accommodation Coefficients for Heat Conduction Between Gas and Bright Platinum, for Nine Gases Between 80°K (or Their Boiling Points) and 380°K

Edward R. Grilly, William J. Taylor, and Herrick L. Johnston

Articles you may be interested in

Accommodation Coefficients for Heat Conduction Between Gas and Bright Platinum, for Nine Gases Between 80°K (or Their Boiling Points) and 380°K

Edward R. Grilly, William J. Taylor,[*,1] and Herrick L. Johnston

Department of Chemistry of The Ohio State University, Columbus, Ohio

(Received May 10, 1946)

Accommodation coefficients toward bright platinum for air, oxygen, nitric oxide, carbon monoxide, carbon dioxide, nitrous oxide, methane, hydrogen, and helium are computed from the $(1/K_a)$ *versus* $(1/P)$ slopes of the thermal conductivity measurements of Taylor and Johnston and of Johnston and Grilly. The results—which cover the temperature range 80°K to 380°K—are tabulated for the several gases, and are collected in a graph where comparison with results obtained by other investigators are also included. Our results with hydrogen rise toward a coefficient of unity with lowering temperature, in confirmation of measurements by others, but those for other gases drop steeply at temperatures between room temperature and that of liquid air. Our data are in generally good agreement with the recent accurate work of Amdur, Jones, and Pearlman, at room temperature. The accommodation coefficients which are derived from the reciprocal K versus reciprocal P plots differ slightly from Knudsen accommodation coefficients, and are referred to as "Maxwell-Knudsen" coefficients. Equations are derived which give the relationship between the reciprocal slopes, the temperature jump constants g', and the M-K accommodation coefficients.

ALTHOUGH the literature contains comparatively little data on the accommodation coefficients of gases below room temperature, it is generally assumed that these tend to approach unity as T approaches zero. In connection with measurements of the thermal conductivities of gases, recently completed in this laboratory[2,3] for the temperature range of 80° to 380°K, by the hot wire method, it was possible to evaluate accommodation coefficients on the cell wire of bright platinum.

RELATION BETWEEN ACCOMMODATION COEFFICIENT AND RECIPROCAL PLOT

The calculation of accommodation coefficients, from the thermal conductivity data, is based on the experimental slopes of the reciprocal plots of "apparent" conductivity *versus* pressure, for various pressures used in the cell. The "apparent" conductivity, K_a, of the gas is obtained, as outlined in the initial paper[2] of this series, by applying to the experimental (uncorrected) conductivity, K_u, all the necessary corrections except that for the "temperature-jump" effect. The latter is the effect of the temperature discontinuity which exists at a gas-solid interface when heat flows across the interface.[4] The temperature in the body of a gas will vary in a way determined by the boundary conditions of the system. Thus the temperature varies linearly with distance for heat flow between parallel plates, and linearly with the logarithm of the radial distance for heat flow between concentric cylinders (as in a hot wire cell). However the particular way in which the gas molecules incident upon the surface are reflected from it (or re-emitted after adsorption), and, further, the way in which the reflected and incident molecules interact through collisions, affects the condition of the gas within a few mean-free-path lengths of the surface. As a result the temperature in the gas near the surface will deviate from the functional relation which obtains in the body of the gas, and the extrapolation of the latter relation to the surface will yield a temperature different than the temperature of the surface. This temperature discontinuity will be denoted by δT.[5]

Experiment has established, and the theory, in so far as it has been developed, supports the fact that δT is proportional to the temperature gradient in the gas at the surface (as extrapolated from the body of the gas), and is inversely pro-

---

* Present address: American Petroleum Institute Research Project 44, National Bureau of Standards, Washington, D. C.

[1] Fellow of the Charles A. Coffin Foundation 1939–40; E. I. du Pont Fellow 1940–41.

[2] W. J. Taylor and H. L. Johnston, J. Chem. Phys. 14, 219 (1946).

[3] H. L. Johnston and E. R. Grilly, J. Chem. Phys. 14, 233 (1946).

[4] E. H. Kennard, *Kinetic Theory of Gases* (McGraw-Hill Book Company, Inc., New York, 1938), Sections 176–177.

[5] The actual temperature of the gas at the surface will also differ from the temperature of the surface, although by an amount less than δT.

portional to the pressure of the gas (or directly proportional to the mean-free-path length). Thus

$$\delta T = g \frac{\partial T}{\partial r} = (g'/p) \frac{\partial T}{\partial r}, \qquad (1)$$

where g' is independent of the pressure, p. The constant g has been called the temperature jump distance.[4] It is suggested that g' be called the temperature jump coefficient.

In the hot wire cell a temperature discontinuity is found at the surface of the cell wire, and to a lesser extent at the surface of the cell wall. The discontinuity which enters into the derivation of the equations for the present cell is δT, as defined here. As a result of these discontinuities, the apparent conductivity of the gas is a function of the pressure of the gas (as well as of other constants of the gas and of the apparatus). It has been shown previously[2] that a plot of the reciprocal of the apparent conductivity, K_a, *versus* the reciprocal of the pressure, yields a straight line, and that the intercept at $(1/p) = 0$ is the reciprocal of the true conductivity, K, or

$$1/K_a = 1/K + A/P. \qquad (2)$$

The slope A is related to the coefficient g' of Eq. (1) by the expression[2]

$$A = \frac{d(1/K_a)}{d(1/p)} = \frac{1}{\ln (r_2/r_1)}$$
$$\times [(g_1'/K_1 r_1) + (g_2'/K_2 r_2)], \qquad (3)$$

where the subscripts 1 and 2 refer to the surfaces, or temperatures, of the cell wire and the cell wall, respectively. The term $(g_2'/K_2 r_2)$ in Eq. (3) makes only a small contribution, since $(g_2'/K_2) \cong (g_1'/K_1)$, and $(1/r_2) = 0.032(1/r_1)$. It is therefore permissible to set (g_2'/K_2) equal to (g_1'/K_1), whereupon Eq. (3) may be solved for g_1',

$$g_1' = \ln (r_2/r_1) \cdot [(1/r_1) + (1/r_2)]^{-1} \cdot K_1 A. \qquad (4)$$

If in Eqs. (1) to (4), r is expressed in centimeters, and p in centimeters of mercury, then g' has the units centimeters times centimeters of mercury. On introducing the dimensions of the present cell, Eq. (4) becomes,

$$g_1' = 0.0426 \cdot K_1 A. \qquad (4a)$$

The constant g_1' is dependent upon the nature of

the gas and of the surface, but is independent of the dimensions of the apparatus[6] or of the pressure of the gas. It should be emphasized that the validity of Eq. (1) is confirmed by the fact that the observed data are precisely in accord with Eq. (2), and that the values of g_1' calculated from Eq. (4) are not dependent upon any detailed theory of the interaction of the molecules of the gas with the surface. The usefulness of g' lies in the fact that it may be used with Eq. (1) to calculate δT for the same gas and surface in any other situation in which they occur. In such a case the derivative in Eq. (1) is merely the derivative normal to the surface, whether the surface is curved or flat.

The accommodation coefficient of the gas molecules on the surface has been calculated from the value of g' and a theoretical relation connecting these two constants.

Knudsen's accommodation coefficient, for heat conduction across a gas-solid interface, is defined as the ratio[4]

$$a = (E_i - E_r)/(E_i - E_r'), \qquad (5)$$

when E_i is the energy carried (per unit time) by the stream of molecules incident upon the surface, E_r is the energy carried by the molecules reflected (or re-emitted) from the surface, and E_r' is the energy that would be carried by the reflected molecules if they were issuing as a stream out of a body of gas at equilibrium at the temperature of the surface.[7] This accommodation coefficient is therefore the ratio of the net energy actually flowing across the surface to the value the latter would have if the incident stream of molecules were unchanged but the reflected stream were replaced by a stream in "thermal equilibrium" with the solid. A theoretical relation between g' and Knudsen's accommodation coefficient has not as yet been obtained and probably no simple relation between them exists, because of the complex nature of the actual stream of incident molecules. However, it is possible to relate g' to a slightly different

---

[6] It is assumed that, as in the case in the present measurements, the length of the mean free path in the gas is small relative to the diameter of the cell wire.

[7] The "pressure" of this gas is to have a value such that the issuing stream contains the same number of molecules as the actual incident and reflected streams.

constant, defined as

$$a' = (E_i - E_r)/(E_i' - E_r'). \qquad (6)$$

E_i, E_r, and E_r' have been defined following Eq. (5),[8] and E_i' is the energy the incident stream of molecules would carry if the temperature gradient in the body of the gas continued uniformly to the surface (in which case the temperature discontinuity at the surface would be δT of Eq. (1)). It is suggested that a' be called the Maxwell-Knudsen accommodation coefficient, since the definition is based upon the work of both men.[4] The expression relating g' and a' is[4]

$$g' = (2\pi RMT)^{\frac{1}{2}}\left(\frac{K}{2C_v + R}\right)\left(\frac{2-a'}{a'}\right), \qquad (7)$$

where R is the molar gas constant, M is the molecular weight of the gas, and K and C_v are the thermal conductivity and heat capacity (at constant volume) of the gas at the temperature $T(°K)$ of the surface. On introducing the value of R and appropriate conversion factors, and solving for a', Eq. (7) becomes:

$$a' = \left[(1/2) + \frac{0.583}{(MT)^{\frac{1}{2}}}\frac{C_v + 0.994}{K}g'\right]^{-1}, \qquad (8)$$

where the units are: C_v, calories per degree per mole; K, calories per centimeter per degree per second; and g', centimeters times centimeters of mercury.

The only approximation of any significance in the derivation of Eq. (7) is the assumption that the heat capacity for internal energy (excluding translation) of a stream of molecules issuing from a body of gas at equilibrium is the same (per mole) as for the entire gas. This assumption is not likely to be seriously in error unless there
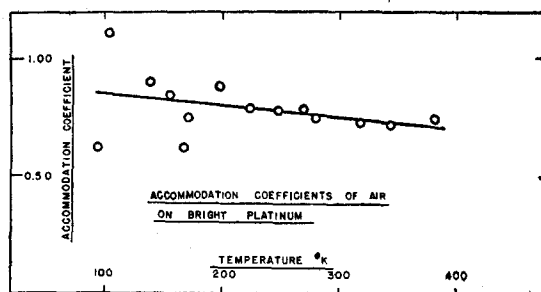

FIG. 1. Accommodation coefficient of air on bright platinum.

is a strong correlation between the average internal energies of the molecules and their translational velocities. Account is taken of the fact that the heat capacity for translational energy is $2R$ for the issuing stream as compared with $3R/2$ for the entire gas.

It seems desirable to recognize that g' yields the accommodation coefficient a', rather than a. Measurements at lower pressures, such that free-molecule conduction exists, are generally considered to yield the Knudsen coefficient, a. However, it should be pointed out that approximations have been necessary in the theoretical treatment of free-molecule conduction.[9] A comparison of values of a and a' would indicate the difference between the values of E_i and E_i' in Eq. (6).

The accommodation coefficients for air, obtained by Taylor and Johnston[2] are given in Table I, and are graphed in Fig. 1. Those for the eight gases investigated by Grilly and Johnston[3] are given in Tables II–IX, inclusive, and are graphed in Fig. 2. Units employed in the several tables are as follows: T, wire temperature in degrees Kelvin; P, centimeters of mercury; K, (apparent), calories per centimeter per second per degree $\times 10^5$; g', centimeters $\times$ centimeters of mercury $\times 10^5$.

The pressures, at which apparent K's for air were obtained by Taylor and Johnston are given in Table IV of their paper, and are not quoted here. Certain of Taylor and Johnston's results—namely those for wire temperatures of 104° and 139°K—are based on plots of three points that were not quite linear. The remaining points below 175° were based on runs at only two pressures. This probably accounts for the spread

TABLE I. Accommodation coefficients of air on bright platinum.

T, °K	$d(1/K)/d(1/P)$	g'	a'	T, °K	$d(1/K)/d(1/P)$	g'	a'
94	378	33	0.62	224	405	83	0.79
104	145	14	1.11	248	434	97	0.78
139	254	33	0.90	270	448	107	0.78
155	299	44	0.85	280	491	121	0.75
167	505	79	0.62	318	547	149	0.73
171	383	62	0.75	344	576	167	0.72
198	313	58	0.88	382	574	181	0.74

[8] However in the present case the stream for E_r' is defined to contain the same number of molecules as the stream for E_i' (rather than for E_i, as in footnote 7).
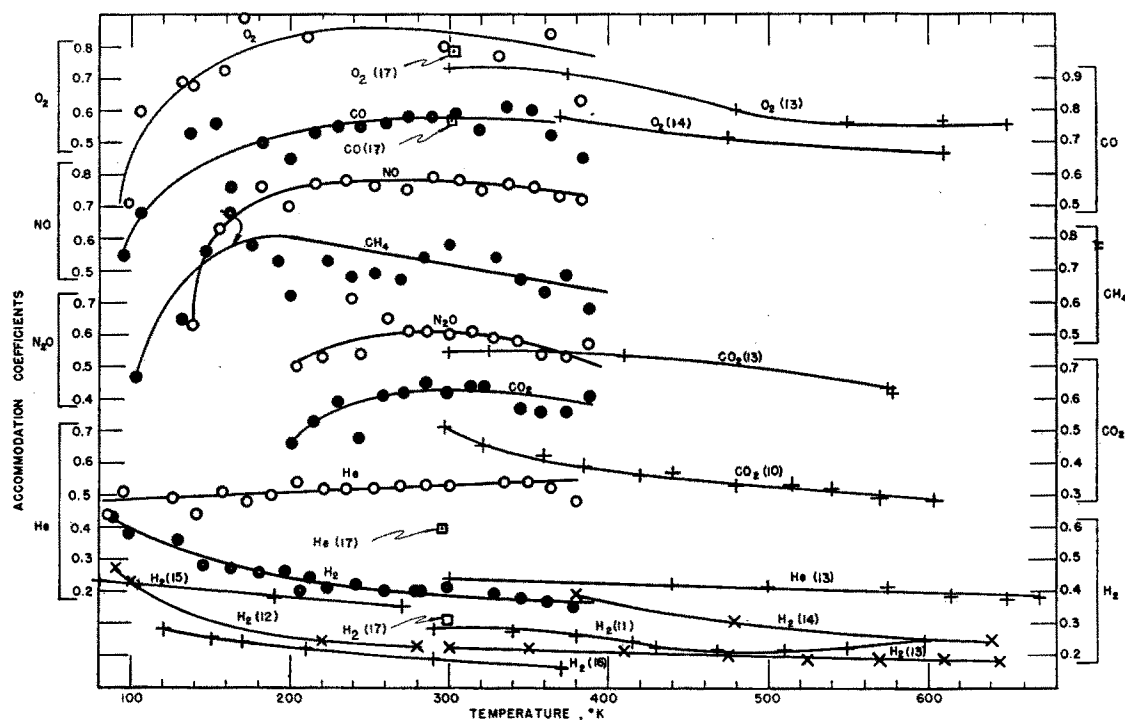
[9] E. H. Kennard, reference 4 (Sections 178–179).

FIG. 2. Accommodation coefficient of several gases on bright platinum. Experimental points, ○ ● This research, + □ Other investigators (references indicated).

TABLE II. Accommodation coefficients of oxygen on bright platinum.

T, °K	P_1	P_2	P_3	K_1	K_2	K_3	$\frac{d(1/K)}{d(1/P)}$	g'	a'
99	1.125	3.35	9.36	2.000	2.029	2.033	1020	93	0.31
106	1.870	8.99	8.99	2.103	2.108	2.111	440	44	0.60
132	1.625	4.21	9.20	2.768	2.767	2.771	403	50	0.69
139	1.711	4.63	8.12	2.838	2.846	2.852	420	56	0.68
159	1.537	4.39	6.65	3.298	3.312	3.318	400	61	0.73
172	1.541	5.05	9.27	3.648	3.668	3.667	280	47	0.89
212	1.125	4.16	11.09	4.422	4.469	4.481	374	73	0.83
297	1.294	3.90	11.09	6.044	6.138	6.165	472	127	0.80
331	2.000	5.00	8.99	6.709	6.779	6.801	520	155	0.77
364	1.406	4.73	8.64	7.356	7.483	7.513	475	156	0.84
383	1.556	4.08	8.61	7.676	7.868	7.920	750	258	0.63

TABLE III. Accommodation coefficients of nitric oxide on bright platinum.

T, °K	P_1	P_2	P_3	K_1	K_2	K_3	$\frac{d(1/K)}{d(1/P)}$	g'	a'
139	1.851	5.72	10.72	2.763	2.781	2.795	940	121	0.33
156	1.646	4.28	10.86	3.139	3.153	3.161	440	63	0.63
182	1.387	6.46	10.01	3.689	3.717	3.720	364	61	0.76
199	1.312	5.27	9.97	4.020	4.064	4.070	450	80	0.70
216	2.530	5.89	10.65	4.381	4.398	4.404	396	78	0.77
235	1.531	6.75	10.48	4.733	4.780	4.785	410	87	0.78
253	1.511	5.07	10.53	5.064	5.114	5.129	444	101	0.76
273	1.697	5.20	10.40	5.461	5.515	5.530	466	113	0.75
290	1.871	4.73	10.44	5.776	5.827	5.842	446	114	0.79
306	1.975	5.41	10.50	6.079	6.135	6.151	472	126	0.78
320	1.756	5.87	10.51	6.325	6.405	6.423	512	143	0.75
337	1.711	4.86	10.53	6.621	6.704	6.730	500	147	0.77
353	1.756	4.70	10.44	6.912	7.001	7.037	544	165	0.76
369	1.712	4.36	10.56	7.188	7.292	7.341	592	188	0.73
383	1.761	4.78	10.58	7.437	7.557	7.597	596	197	0.72

of their data below 175°K. For purposes of extrapolation—i.e., to obtain thermal conductivities—the slight non-linearity is less serious than in the determination of accommodation coefficients, where slopes themselves are used.

Comparisons with results obtained by other investigators[10-17] are included in Fig. 2. The measurements in references 13 to 17 were made at low pressures, where free molecule conduction exists, and presumably yield values of Knudsen's accommodation coefficient a, while those in references 10 to 12 were made at higher pressures ($p > 1$ cm), and should yield essentially the

[10] C. T. Archer, Proc. Roy. Soc. (London) A165, 474 (1938).
[11] H. S. Gregory (Spencer-Gregory), Proc. Roy. Soc. (London) A149, 35 (1935).
[12] H. Spencer-Gregory and E. H. Dock, Phil. Mag. 25, 129 (1938).
[13] L. B. Thomas and F. Olmer, J. Am. Chem. Soc. 65, 1036 (1943).
[14] W. B. Mann, Proc. Roy. Soc. (London) A146, 776 (1934).
[15] M. Knudsen, Ann. d. Physik 34, 593 (1911).
[16] H. H. Rowley and K. F. Bonhoeffer, Zeits. f. physik. Chemie B21, 84 (1933). Recalculated by Thomas and Olmer, reference 13.
[17] I. Amdur, M. C. Jones, and H. Pearlman, J. Chem. Phys. 12, 159 (1944).

accommodation coefficient a'.[18] Both types of measurements refer to a platinum surface saturated with gas, with the exception of some of the measurements of Mann[14] which were made on a gas free surface.[19]

TABLE IV. Accommodation coefficients of hydrogen on bright platinum.

T, °K	P_1	P_2	P_3	K_1	K_2	K_3	$\frac{d(1/K)}{d(1/P)}$	g'	a'
88	1.608	4.57	10.60	13.74	13.84	13.87	130	80	0.63
98	1.518	4.65	10.90	15.18	15.33	15.38	152	112	0.58
129	2.045	5.38	11.76	19.57	19.78	19.83	164	140	0.56
145	1.886	5.29	12.23	21.94	22.27	22.41	214	208	0.48
162	1.857	5.26	10.76	24.19	24.66	24.77	220	236	0.47
180	1.850	4.67	11.12	26.27	26.80	27.02	236	280	0.46
197	1.507	4.01	11.04	28.10	28.84	29.20	232	298	0.46
206	2.005	5.02	10.48	24.53	30.28	30.61	296	396	0.40
212	1.373	4.80	10.80	29.84	31.08	31.37	254	347	0.44
223	2.085	4.83	10.49	31.78	32.57	32.94	288	416	0.41
241	1.811	5.45	10.60	33.81	35.07	35.40	290	459	0.42
259	1.866	5.03	10.68	35.65	37.00	37.48	302	490	0.40
279	1.846	5.30	10.73	37.43	39.02	39.52	316	541	0.40
282	1.339	4.26	10.45	36.57	38.75	39.55	316	545	0.40
298	1.607	4.48	12.42	38.39	40.36	41.14	304	539	0.41
328	1.309	4.78	12.01	39.81	43.05	43.95	348	665	0.39
345	1.518	4.77	9.35	41.35	44.34	45.11	362	715	0.38
361	1.464	4.53	10.38	42.17	45.69	46.70	390	795	0.37
378	1.493	5.07	10.75	43.11	47.19	48.31	430	905	0.35

TABLE V. Accommodation coefficients of carbon dioxide on bright platinum.

T, °K	P_1	P_2	P_3	K_1	K_2	K_3	$\frac{d(1/K)}{d(1/P)}$	g'	a'
201	1.882	4.37	8.39	2.054	2.065	2.069	875	85	0.46
215	1.722	4.24	8.44	2.264	2.273	2.280	710	76	0.53
230	1.722	4.95	9.86	2.504	2.516	2.522	620	72	0.59
243	1.771	4.17	9.89	2.716	2.739	2.747	900	108	0.48
258	1.781	5.17	9.31	2.973	2.990	2.996	590	80	0.61
271	1.646	4.66	9.33	3.208	3.229	3.238	590	87	0.62
285	1.647	4.05	8.08	3.464	3.487	3.496	570	90	0.65
298	1.567	4.08	8.09	3.703	3.730	3.743	580	97	0.62
313	1.567	4.08	6.93	3.974	4.007	4.021	610	110	0.64
321	1.184	3.30	6.95	4.116	4.169	4.186	580	109	0.64
344	1.743	4.31	10.37	4.571	4.616	4.637	670	139	0.57
357	1.743	4.71	10.04	4.838	4.891	4.912	700	154	0.56
373	1.702	4.63	10.05	5.165	5.229	5.257	710	166	0.56
388	1.707	4.21	9.66	5.497	5.567	5.594	620	153	0.61

TABLE VI. Accommodation coefficients of nitrous oxide on bright platinum.

T, °K	P_1	P_2	P_3	K_1	K_2	K_3	$\frac{d(1/K)}{d(1/P)}$	g'	a'
204	2.115	4.19	10.41	2.157	2.163	2.171	825	83	0.50
220	1.772	4.77	10.27	2.416	2.428	2.434	680	76	0.53
238	1.906	4.57	8.66	2.743	2.749	2.756	460	55	0.71
244	1.862	4.79	9.83	2.840	2.857	2.864	685	89	0.54
261	1.777	4.92	10.06	3.143	3.160	3.167	530	77	0.65
274	1.847	4.52	10.59	3.386	3.406	3.415	590	91	0.61
286	1.702	4.86	10.91	3.624	3.649	3.661	570	93	0.61
301	1.448	4.31	10.90	3.897	3.931	3.949	580	102	0.60
314	1.748	4.78	10.89	4.160	4.193	4.207	590	112	0.61
327	1.611	6.04	12.30	4.430	4.483	4.498	640	128	0.59
342	1.591	5.15	12.25	4.733	4.791	4.814	660	142	0.58
357	2.367	5.12	11.20	5.070	5.109	5.132	720	165	0.54
373	2.049	5.30	11.13	5.399	5.455	5.484	740	181	0.53
387	2.203	5.67	10.96	5.731	5.790	5.814	660	170	0.57

[18] However, the accommodation coefficient calculated in references 10 to 12 is not identical with a' because the theory used by these workers differs from that presented here. In this connection, see the comment of Kennard (reference 4, pages 323–324), on the formula used by Dickins, reference 20 (Proc. Roy. Soc. (London) **A143**, 517 (1934)). Gregory (reference 11) presumably used the same formula as Dickins, while Archer (reference 10) and Spencer-Gregory and Dock (reference 12) used a different theory developed by one of them.

TABLE VII. Accommodation coefficients of carbon monoxide on bright platinum.

T, °K	P_1	P_2	P_3	K_1	K_2	K_3	$\frac{d(1/K)}{d(1/P)}$	g'	a'
95	1.832	5.56	10.00	1.790	1.795	1.801	790	67	0.35
106	2.140	4.91	10.20	2.029	2.035	2.037	550	52	0.48
138	1.628	5.27	9.58	2.702	2.711	2.714	350	53	0.73
154	1.901	5.40	10.10	3.037	3.049	3.051	350	47	0.76
163	1.782	5.55	10.00	3.230	3.246	3.256	560	81	0.56
183	2.333	5.48	11.08	3.658	3.670	3.676	410	66	0.70
200	1.771	4.94	11.11	3.967	3.988	4.006	510	90	0.65
215	1.786	4.89	11.01	4.264	4.291	4.301	440	·85	0.73
230	1.632	4.56	11.01	4.548	4.582	4.595	440	89	0.75
244	1.637	4.60	10.74	4.814	4.852	4.866	430	95	0.75
260	1.776	4.40	10.76	5.097	5.148	5.151	440	99	0.76
274	1.766	4.53	10.68	5.341	5.381	5.400	445	105	0.78
289	1.363	4.40	9.99	5.579	5.650	5.670	450	111	0.78
304	1.796	4.38	10.03	5.865	5.912	5.936	450	117	0.79
319	1.800	4.57	9.68	6.223	6.171	6.194	520	140	0.74
336	2.512	6.33	10.35	6.426	6.466	6.485	460	130	0.81
352	2.099	5.43	10.38	6.689	6.756	6.770	470	140	0.80
364	2.467	5.26	10.96	6.912	6.970	6.996	550	168	0.72
384	3.153	8.65	11.20	7.268	7.334	7.346	650	207	0.65

TABLE VIII. Accommodation coefficients of methane on bright platinum.

T, °K	P_1	P_2	P_3	K_1	K_2	K_3	$\frac{d(1/K)}{d(1/P)}$	g'	a'
103	1.901	4.36	7.38	2.438	2.445	2.448	450	50	0.37
132	1.518	4.87	10.86	3.174	3.186	3.192	330	47	0.55
147	1.781	4.88	11.05	3.593	3.597	3.604	220	35	0.76
162	1.682	4.23	10.37	3.979	3.995	3.994	180	32	0.88
176	2.025	4.66	10.01	4.394	4.393	4.400	230	45	0.78
192	2.066	3.98	9.78	4.775	4.787	4.798	270	57	0.73
200	2.245	4.96	9.95	5.203	5.227	5.237	360	80	0.62
223	1.876	4.41	10.81	5.640	5.661	5.679	275	73	0.73
238	2.095	5.06	11.42	6.061	6.092	6.106	320	87	0.68
253	2.190	5.95	11.28	6.492	6.527	6.541	320	92	0.69
269	2.160	5.06	11.27	6.948	6.986	7.010	340	105	0.67
284	1.607	4.34	11.21	7.406	7.471	7.495	300	98	0.74
300	1.955	5.17	10.86	7.930	7.975	8.006	280	97	0.78
329	1.911	4.95	10.85	8.853	8.934	8.961	310	127	0.74
344	1.886	4.64	10.70	9.374	9.468	9.512	360	149	0.67
359	2.300	5.53	10.75	9.974	10.069	10.112	390	172	0.63
373	2.015	5.30	10.80	10.535	10.667	10.695	350	161	0.68
388	2.100	5.07	10.94	11.112	11.264	11.331	440	217	0.58

TABLE IX. Accommodation coefficients of helium on bright platinum.

T, °K	P_1	P_2	P_3	K_1	K_2	K_3	$\frac{d(1/K)}{d(1/P)}$	g'	a'
85	1.885	4.46	10.37	15.31	15.55	15.65	325	220	0.44
95	2.054	4.88	10.32	16.65	16.92	16.94	280	200	0.51
126	2.219	5.46	11.09	19.36	19.71	19.78	300	256	0.49
141	2.188	5.42	11.24	20.62	21.12	21.27	410	382	0.44
157	2.139	5.32	11.40	22.26	22.76	22.95	360	359	0.51
173	2.068	5.11	11.08	23.61	24.24	24.52	400	427	0.48
188	2.078	5.06	11.26	24.82	25.51	25.85	410	463	0.50
204	2.139	5.27	11.18	26.19	26.96	27.25	400	475	0.54
221	2.228	5.49	11.33	27.63	28.47	28.81	415	521	0.52
235	2.178	5.30	11.59	28.71	29.67	30.08	430	563	0.52
252	2.019	4.98	11.38	29.79	30.98	31.48	445	609	0.52
269	2.113	5.07	11.31	30.99	32.20	32.75	450	644	0.53
285	2.073	5.13	11.25	32.03	33.43	34.01	460	683	0.53
300	2.188	5.38	11.15	33.13	34.58	35.19	480	736	0.53
334	1.761	3.58	9.00	34.03	36.17	37.28	480	785	0.54
349	1.457	3.73	9.04	34.64	37.33	38.32	485	816	0.54
364	1.655	4.31	10.64	35.36	38.08	39.19	540	927	0.52
380	1.775	4.60	10.66	36.04	38.85	40.03	590	1035	0.48

[19] However, the work of Amdur, Jones, and Pearlman (reference 17) indicates that in some earlier work, including

In the figure the ordinate scale for each gas has been shifted for better distribution of the points, but qualitatively all the gases are in order of the magnitudes of their accommodation coefficients.

DISCUSSION OF RESULTS

Our own values of a' agree reasonably well with the values of a obtained by Amdur, Jones, and Pearlman,[17] which are probably the most reliable values of a (on a gas-saturated platinum surface) in the literature. This comparison is perhaps the best evidence now available that these two accommodation coefficients do not differ very greatly.

As shown by Fig. 2, the literature is generally lacking in measurements of accommodation coefficients below room temperature—hydrogen (and some data with helium, on glass) being the only gas for which data are published. The accommodation coefficients for hydrogen rise with descending temperature—as confirmed in our own work with this gas. It is generally assumed that the accommodation coefficients of all gases—on all surfaces—tend toward unity as the temperature is lowered. This is because the surface becomes covered with an adsorbed layer of the gas which is thought to be conducive to more efficient energy interchange. However, our own results with gases other than hydrogen consistently indicate sharp decreases in accommodation coefficients at temperatures somewhat below that of the room. This effect is, in fact, most marked for those gases that are most strongly adsorbed. We plan, sometime, to measure the accommodation coefficient of hydrogen

in the neighborhood of its boiling point to discover whether hydrogen also will behave like the other gases in its region of high adsorption.

Some differences among results by different investigators is probably to be expected since we are dealing with a surface effect and surface conditions are probably not exactly comparable.

The observed accommodation coefficient is dependent on the average efficiency of transfer to the surface of the several kinds of molecular energy (translational, rotational, and vibrational) which may be excited in the gas. Some experiments of Knudsen[20] indicate that the accommodation coefficients for translational and rotational energies in hydrogen are essentially the same.

However, it is probable that in general the efficiency of energy transfer is somewhat different for internal degrees of freedom (particularly for vibration) than it is for translation. This has been considered by Shafer, Rating, and Eucken,[21] who assign much lower coefficients to vibrational and rotational than to translational energy. For example, for carbon dioxide at 3°C they assign an accommodation coefficient of unity for translation and rotation but of only 0.13 for vibration.

A relatively low accommodation coefficient for vibrational energy may partially explain the decrease of the accommodation coefficient for the total energy which is generally observed at higher temperatures. However, it cannot explain the decrease at low temperatures observed for several gases in this research.

We see no obvious explanation of the shapes of the curves at low temperatures, and regard it as desirable to investigate the effect further with other gases, and with hydrogen and helium at liquid hydrogen temperatures.

that of Thomas and Olmer (reference 13), the pressure of the gas may have been too low to attain complete saturation of the surface. Accommodation coefficients measured in the region of partial saturation would be expected to be a function of the pressure of the gas.

[20] W. Knudsen, Ann. d. Physik 6, 129 (1930).
[21] K. Shafer, W. Rating, and A. Eucken, Ann. d. Physik 42, 176 (1942).