CHAPTER 6

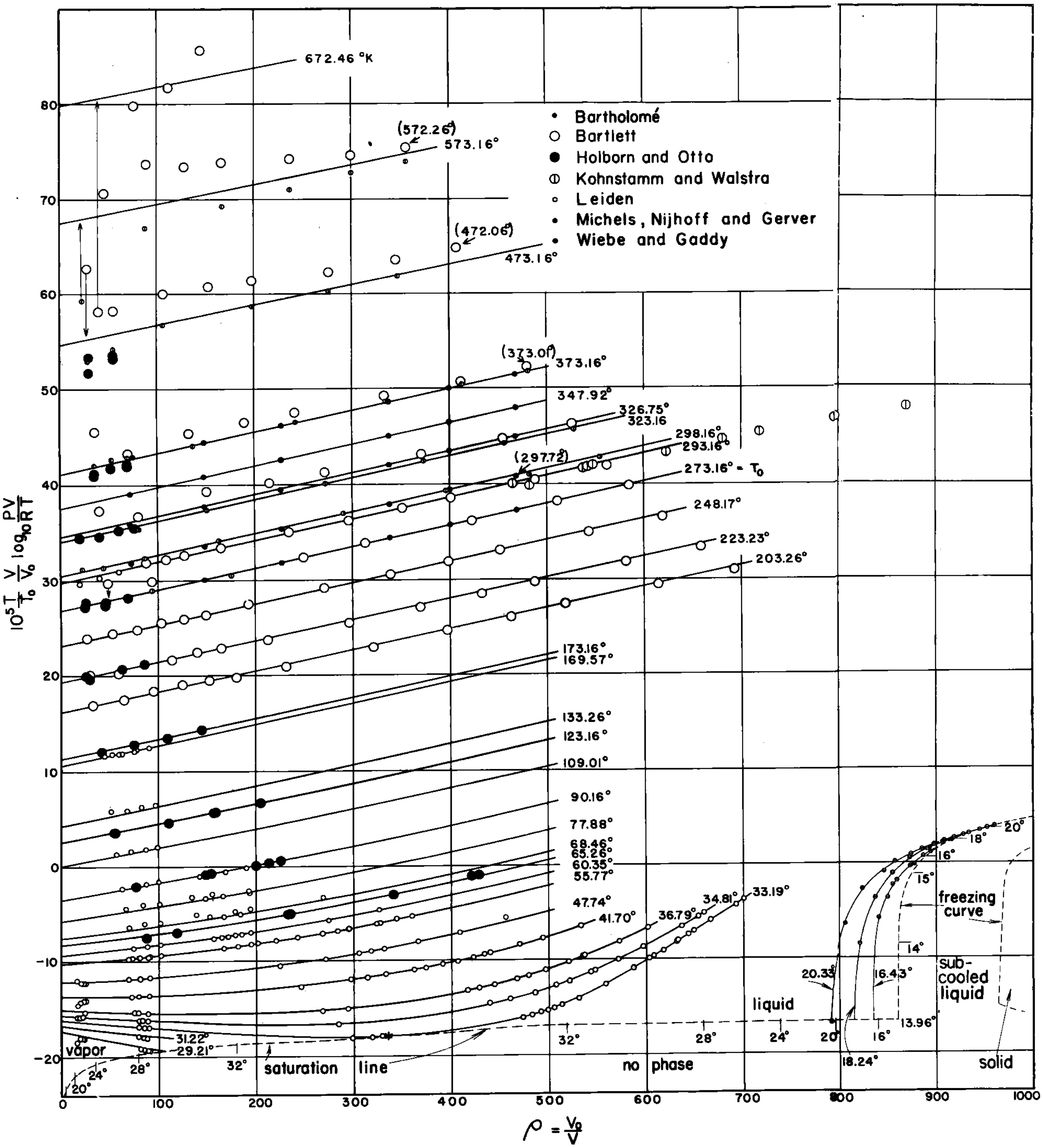
THE THERMODYNAMIC PROPERTIES OF HYDROGEN

The Correlation of the Experimental Data

The most extensive correlation of the thermodynamic properties of hydrogen available is contained in the publication by Woolley, Scott, and Brickwedde [1]. That correlation, partly analytical and partly graphical, treated the region from near condensation to 600°K to a density of 500 Amagats. A full discussion of the experimental data and of the method of correlation is to be found in the above-cited work, where the properties are tabulated as a function of density in Amagat units. Figure 6a, which is taken from this work, shows the extent and distribution of the PVT data employed in this correlation. The deviations of the correlation from the data are shown by the comparison between the solid curves and the plotted experimental points. The calculations in reference 1 of the real-gas corrections or the thermodynamic effects of the deviation from ideality of the gas were carried out by numerical integration and differentiation, with smoothing, of the tabulated compressibility factors. The thermodynamic properties have been calculated for the real gas by combining thermodynamic functions for the ideal gas with the real-gas corrections. The ideal-gas values for the thermodynamic functions for molecular hydrogen are from reference 1. The effect of mixing of the ortho and para forms has been included in the values of the entropy and of the free energy function in tables 6-5 and 6-12; the effect of nuclear spin is not included. The values for atomic hydrogen (table 6-12/a) were calculated by standard methods of statistical mechanics.

The present tabulation of the properties of hydrogen was obtained by interpolation from the values tabulated in reference 1. The tables given below (except for tables 6-11, 6-11/a, and 6-12/a) are for normal hydrogen (75 percent ortho and 25 percent para). The variation of the thermodynamic properties with ortho-para composition is negligible in tables 6-1 and 6-2. For tables 6-3 through 6-6, the influence is essentially dependent on the variation of the ideal-gas thermodynamic properties with composition. The ideal-gas properties for ortho and para hydrogen are given by Woolley, Scott, and Brickwedde [1]. The change in the sound velocity can be computed from the changes in the specific-heat ratio.

The directly determined experimental data include: specific heat by Scheel and Heuse [19], Eucken [20], and Workman [21]; isentropic cooling by expansion in the Lummer-Pringsheim method by Brinkworth [22], Eucken and Mücke [23], and Partington and Howe [24]; apparent values of C_V from the heat required for increases in gas pressure by Giacomini [25]; isentropic heating by compression of mixtures to ignition by Crofts [26]; the ratio of specific heats or the isentropic expansion coefficient in the resonance method of Clark and Katz [27, 28] and Koehler [29]; and the velocity of sound by Cornish and Eastman [30], Van Itterbeek and Mariens [31], Van Itterbeek and Van Doninck [32, 33], and Hodge [34]. Joule-Thomson data by Johnston, et al., [35, 36] are in fair agreement with this correlation.



V_0 is the molar volume of gas at 1 - atm. pressure and the ice point.

Figure 6a. PVT data for hydrogen available in 1948

The dimensionless representation has been accomplished for certain properties by expressing them relative to the value at standard conditions (0°C and 1 atmosphere). Thus, for density, the property is expressed as ρ/ρ_0, for sound velocity as a/a_0, for thermal conductivity as k/k_0, and for viscosity as η/η_0. The reference values, ρ_0, a_0, k_0, and η_0, result, in general, from the correlating equations which were fitted to represent the experimental data over as wide a range as possible. Values for these quantities are given in various units in table 6-b. The value of ρ_0 for hydrogen, as given, 0.0898879 $g\ell^{-1}$, is slightly higher than the experimental measurements [74 - 78] averaging 0.08985 $g\ell^{-1}$, though they may be of lower accuracy than for some gases because of the smaller mass of gas involved. The most recent determination listed here was published in 1918. The value of η_0 for hydrogen as given, 8.411×10^{-5} poise, is well within the range of measured values [49, 51, 79 - 87], for which an average is 8.4522×10^{-5} poise, and near to the latest of these, 8.416×10^{-5} poise [49]. The value of k_0 for hydrogen as given, 4.021×10^{-4} cal cm^{-1} sec^{-1}°K^{-1}, is well within the range of measured values [64 - 66, 69, 70, 73, 88 - 101] for which an average is 3.998×10^{-4} cal cm^{-1} sec^{-1}°K^{-1}, with one recent value of 3.965×10^{-4} cal cm^{-1} sec^{-1}°K^{-1} [70] and another of 4.21×10^{-4} cal cm^{-1} sec^{-1}°K^{-1} [102]. The value of a_0 for hydrogen as given, 1261.1 m sec^{-1}, is within the range of experimental values [19, 30, 43, 103 - 108], for which an average is 1269.9 m sec^{-1}, and quite close to some of them such as 1260.9 m sec^{-1} [30], though the most recent determination listed here is 1286 m sec^{-1} [108].

The tables of viscosity and thermal conductivity were computed from the equations given in summary tables 1-B and 1-C, and the Prandtl numbers were computed from these and the tabulated specific heats.

The tables and equations selected to represent the vapor pressures of liquid $e - H_2$ are based on the work of Hoge and Arnold [37]; the critical points are those of Hoge and Lassiter [38]; and the vapor pressures of the solid and the triple point are taken from Woolley, Scott, and Brickwedde [1]. The prefix "e-" indicates an ortho-para composition corresponding to equilibrium at 20.4°K (0.21 percent ortho and 99.79 percent para). When approximate values of vapor pressures of normal hydrogen ($n - H_2$: 75 percent ortho, 25 percent para) are desired, they may be obtained by computing the values for $e - H_2$ at the same temperatures and multiplying by 0.96. More accurate values of vapor pressure for any mixture of para and ortho hydrogen in the range from the triple point to the boiling point may be computed from equations in reference 39.

The Reliability of the Tables

The tables are thought to be more reliable in the region from 0°C to 100°C than at temperatures considerably higher or lower where experimental difficulties are considerably greater. Inspection of figure 6a indicates that the best data have been fitted so closely in the good experimental region that the uncertainty here is of the order of a percent or two of $Z-1$ and probably somewhat better over most of the range of densities. For temperatures considerably higher or lower, the uncertainties are much greater. Although the fitting of virial coefficients with functions based on a suitable model would have been appropriate, the calculation of the present tables has not been based on such a procedure. Rather, the tables are a more direct representation of the data, though with some similarity to the results obtained using the Lennard-Jones 6-12 potential in the treatment for the region above 0°C. There is considerable uncertainty in the extrapolation

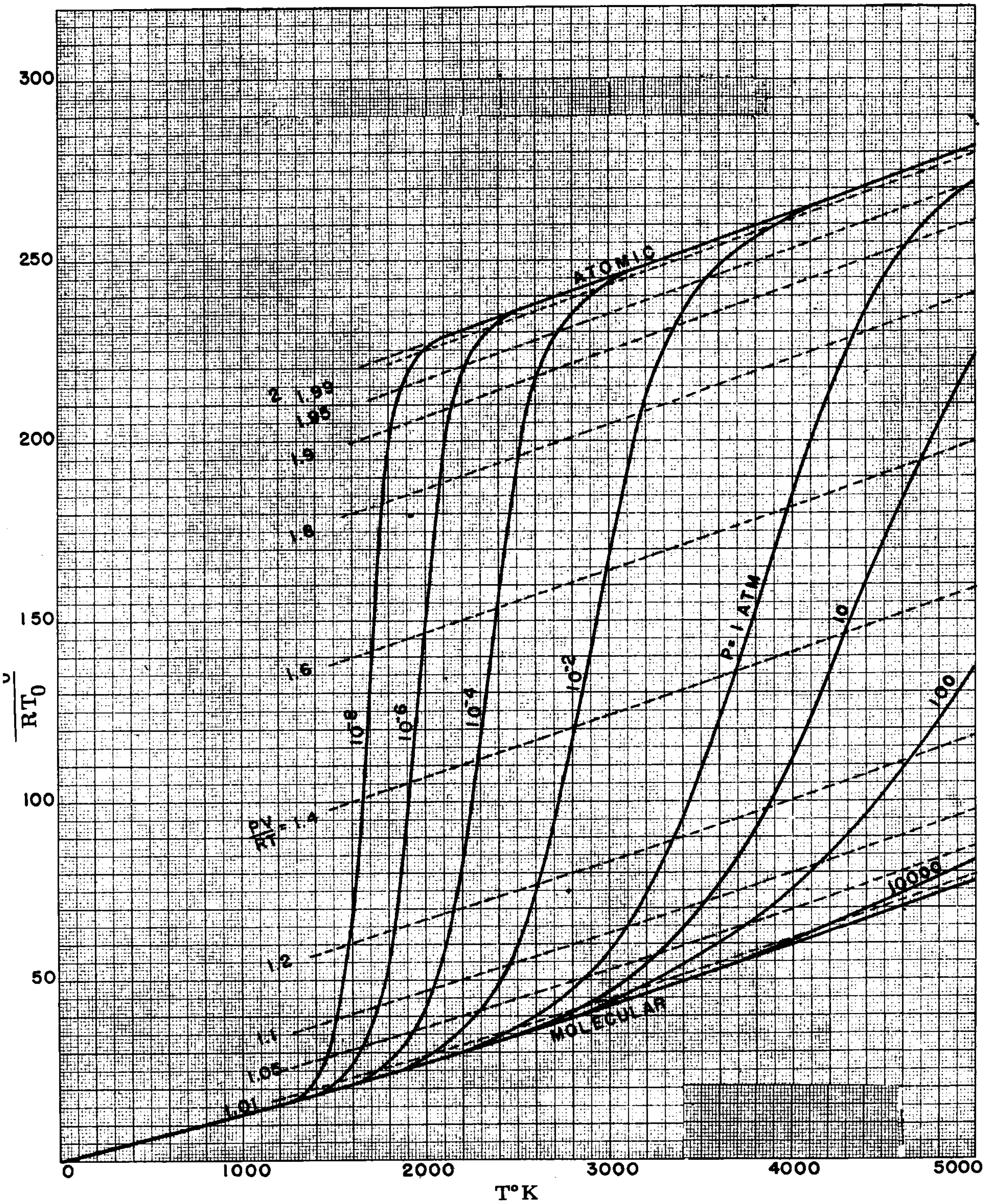


Figure 6b. The effect of dissociation on the enthalpy of hydrogen

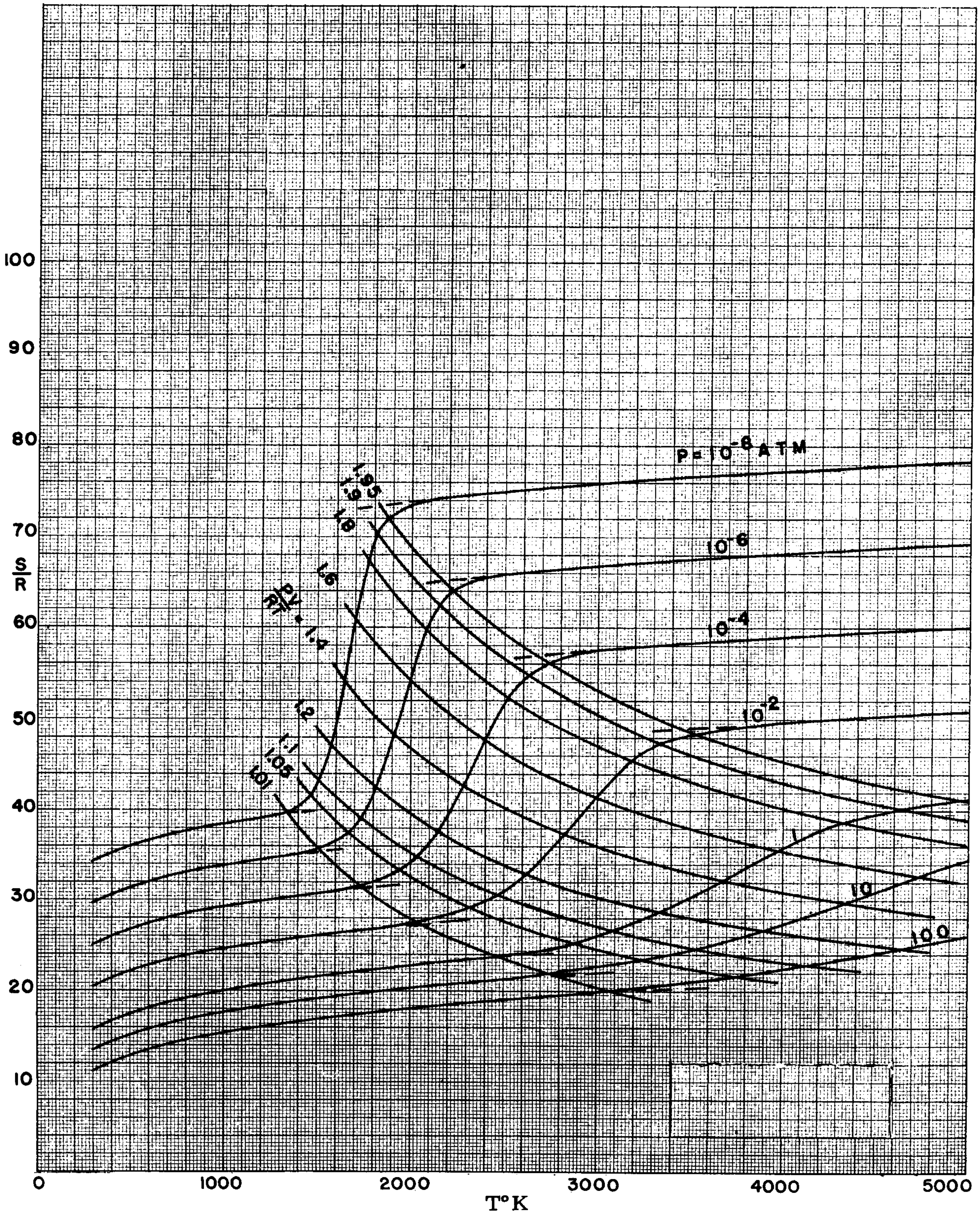


Figure 6c. The effect of dissociation on the entropy of hydrogen

to 600°K, the highest temperature covered, probably more than if the calculation had been based on a definite, reasonably acceptable intermolecular potential function. The derived corrections to the thermodynamic properties are, in the main, uncertain by amounts much greater than the 1 or 2 percent of Z-1, because of the increase in uncertainty in differentiation.

The accuracy of the specific-heat values (table 6-3) is doubtless not uniform throughout the table. The error in $(C_p - C_p^o)/R$ may possibly be about 10 percent, and may be considerably larger than this at low and at high temperatures. The effect of dissociation is not included here, but its magnitude may be estimated in the way indicated in reference 40. The effect on entropy and enthalpy can be estimated from figures 6b and 6c. The uncertainty in the tabulated values of enthalpy for the real gas has been very roughly estimated as 5 percent of the difference between the values of the function for the real and for the ideal gas. At 400°K and 100 atmospheres, the uncertainty in $(H - E_0^o)/RT_0$ amounts to about 0.003. The numerical uncertainty is probably considerably greater at higher temperatures and at quite low temperatures at this pressure, but is less at lower pressures. The values of S/R at 100 atmospheres appear to be uncertain by about 0.003 near 200°K with values less certain at lower temperature and possibly at the highest temperatures tabulated. At lower pressures, the values are thought to be more reliable.

On the basis of the reliabilities estimated for specific heats and compressibility factors, the values of γ (table 6-6) are considered to be reliable to within 10 percent of the departure from values for the ideal gas. A comparison with indirect experimental determinations of γ is shown in figure 6d.

The values of sound velocity at low frequency are thought to be quite reliable except at the lowest temperatures and at elevated pressures. The uncertainty is probably less than 0.001 for pressures of 10 atmospheres or less. For 100 atmospheres, it is probably less than 0.006 up to 100°K, 0.002 up to 200°K, and 0.001 at higher temperatures. Figure 6e shows the departure between the experimental data and the tabulated values.

The values of viscosity (table 6-8) were computed from the empirical equations given in summary table 1-B. Below 100°K, small corrections were applied to take into account the effect of density below the boiling point. Figure 6f is a comparison of the experimental results with those obtained from the empirical formula. The solid curve below the zero line represents the Sutherland equation fitted to the best data at 300°K and shows the inapplicability of this formula to the data for hydrogen. It is thought that the values of viscosity are reliable to within 0. 4 percent between 200°K and 400°K. Below 100°K, the uncertainty is probably as great as 1 percent.

The values of thermal conductivity (table 6-9) were computed from the empirical formula given in table 1-C. The estimated accuracy of the tabulated thermal conductivity is about 5 percent as is illustrated by figure 6g.

Figure 6h shows the experimental vapor pressure data of [37] plotted as deviations from table 6-11. The pressures given for $e\text{-}H_2$ are believed to be accurate to 0.2 or 0.3 mm Hg up to about 1 atmosphere. Above 1 atmosphere, the uncertainty gradually increases, reaching perhaps ±8 mm Hg near the critical points. Uncertainty in the temperature scale is perhaps ±.020 degree, which is greater than the scatter of the data.

The reliability of the ideal-gas properties is indicated in summary table 1-D.

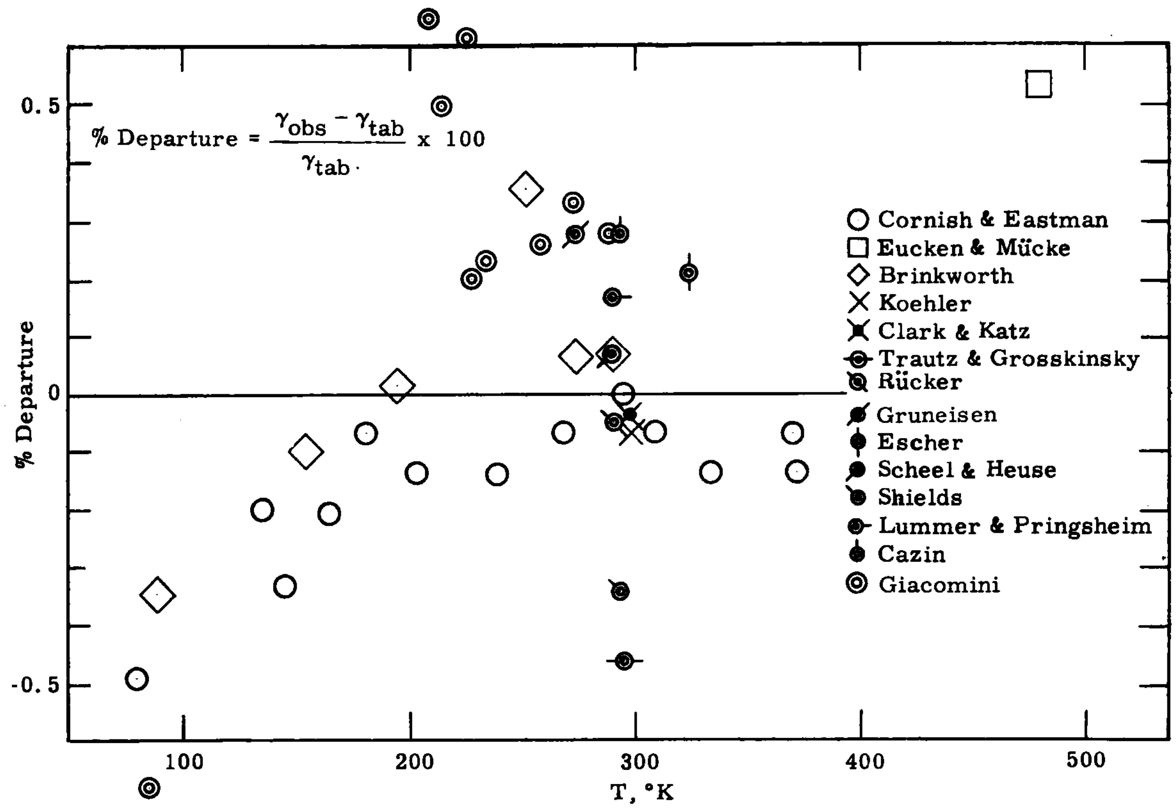


Figure 6d. Departures of experimental values of γ from the tabulated values for hydrogen (table 6-6)

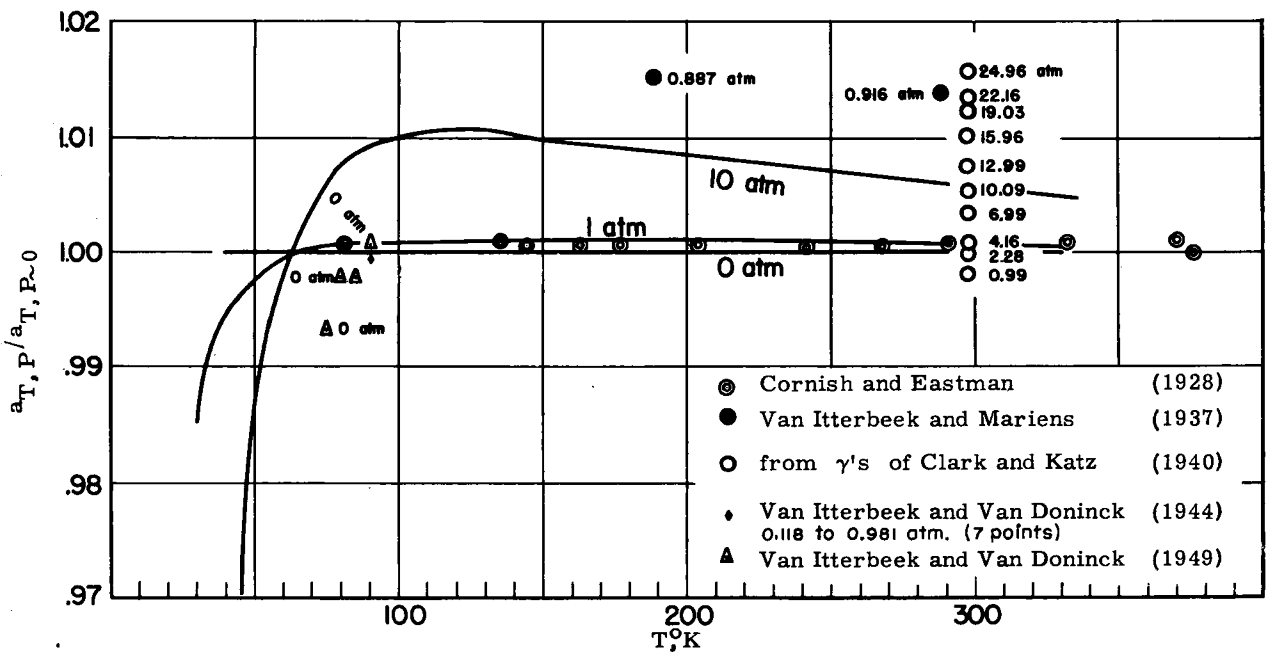


Figure 6e. Ratios of tabulated and experimental sound velocities to the calculated low-pressure values

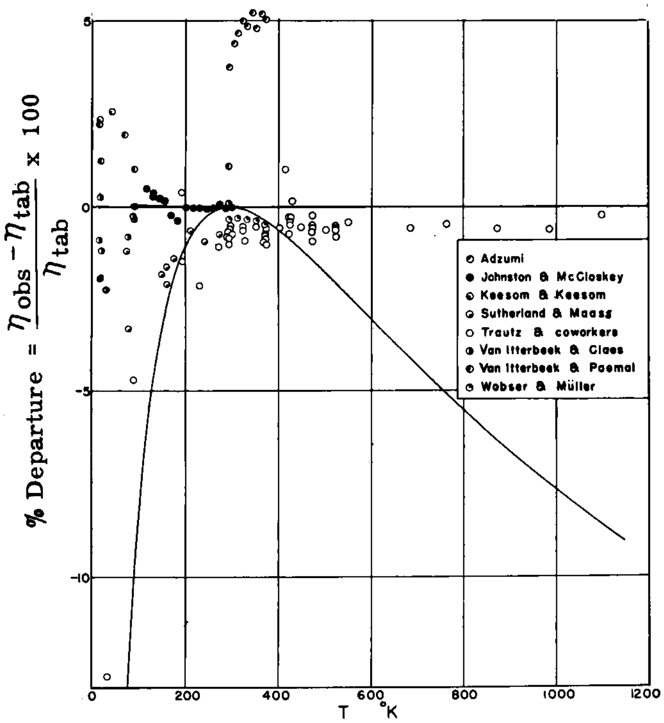


Figure 6f. Departures of experimental viscosities from the tabulated values for hydrogen (table 6-8)

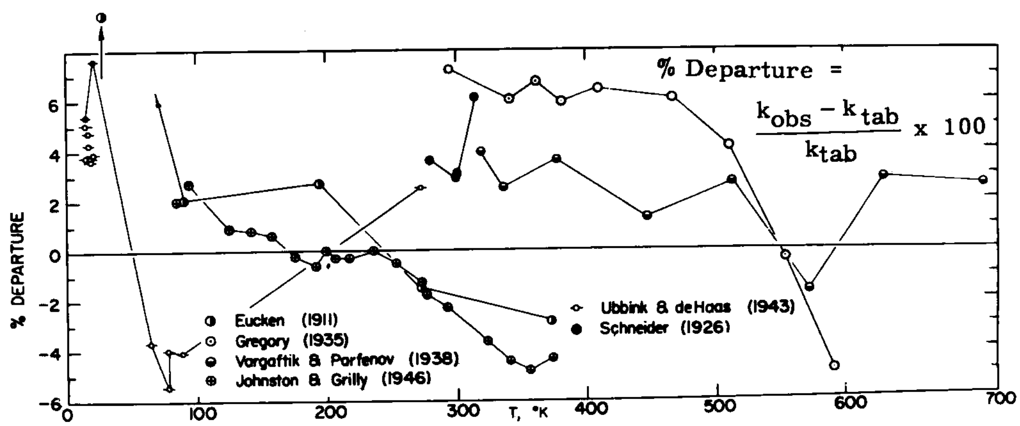


Figure 6g. Departures of experimental thermal conductivities from the tabulated values for hydrogen (table 6-9)

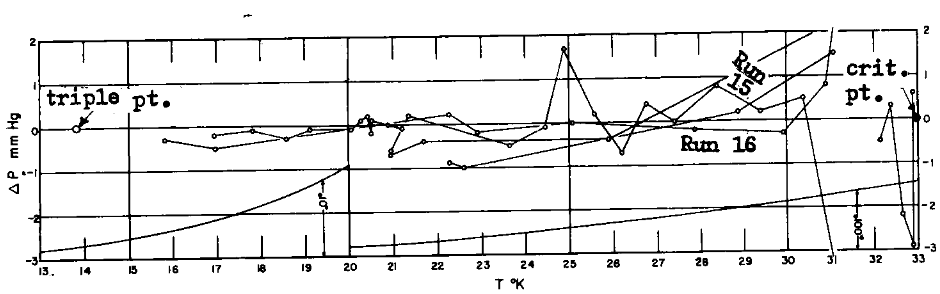


Figure 6h. Departures of experimental vapor pressures from the tabulated values for hydrogen (table 6-11)

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Table 6-a. VALUES OF THE GAS CONSTANT, R, FOR MOLECULAR HYDROGEN

Values of R for Molecular Hydrogen for Temperatures in Degrees Kelvin

Density \ Pressure	atm	kg/cm^2	mm Hg	lb/in^2
g/cm^3	40.7027	42.0551	30934.1	598.169
$mole/cm^3$	82.0567	84.7832	62363.1	1205.91
mole/liter	0.0820544	0.0847809	62.3613	1.20587
lb/ft^3	0.651989	0.673653	495.512	9.58163
lb $mole/ft^3$	1.31441	1.35808	998.952	19.3166

Values of R for Molecular Hydrogen for Temperatures in Degrees Rankine

Density \ Pressure	atm	kg/cm^2	mm Hg	lb/in^2
g/cm^3	22.6126	23.3639	17185.6	332.316
$mole/cm^3$	45.5871	47.1018	34646.2	669.950
mole/liter	0.0455858	0.0471005	34.6452	0.669928
lb/ft^3	0.362216	0.374252	275.284	5.32313
lb $mole/ft^3$	0.730228	0.754489	554.973	10.7314

Table 6-b. CONVERSION FACTORS FOR THE MOLECULAR HYDROGEN TABLES

Conversion Factors for Table 6-2

To Convert Tabulated Value of	To	Having the Dimensions Indicated Below	Multiply by
ρ/ρ_0	ρ	$g\ cm^{-3}$	8.98854×10^{-5}
		$mole\ cm^{-3}$	4.45860×10^{-5}
		$g\ liter^{-1}$	8.98879×10^{-2}
		$lb\ in^{-3}$	3.24734×10^{-6}
		$lb\ ft^{-3}$	5.61140×10^{-3}

Conversion Factors for Tables 6-4 and 6-12

To Convert Tabulated Value of	To	Having the Dimensions Indicated Below	Multiply by
$(H^o - E_0^o)/RT_0$,	$(H^o - E_0^o)$,	$cal\ mole^{-1}$	542.821
$(H - E_0^o)/RT_0$	$(H - E_0^o)$	$cal\ g^{-1}$	269.256
		$joules\ g^{-1}$	1126.57
		$Btu\ (lb\ mole)^{-1}$	976.437
		$Btu\ lb^{-1}$	484.344

Conversion Factors for Tables 6-3, 6-5, and 6-12

To Convert Tabulated Value of	To	Having the Dimensions Indicated Below	Multiply by
C_p^o/R, S^o/R,	C_p^o, S^o,	$cal\ mole^{-1}\ {}^oK^{-1}$ (or ${}^oC^{-1}$)	1.98719
C_p/R, S/R,	C_p, S,	$cal\ g^{-1}\ {}^oK^{-1}$ (or ${}^oC^{-1}$)	0.985709
$-(F^o - E_0^o)/RT$	$-(F^o - E_0^o)/T$	$joules\ g^{-1}\ {}^oK^{-1}$ (or ${}^oC^{-1}$)	4.12422
		$Btu\ (lb\ mole)^{-1}\ {}^oR^{-1}$ (or ${}^oF^{-1}$)	1.98588
		$Btu\ lb^{-1}\ {}^oR^{-1}$ (or ${}^oF^{-1}$)	0.985060

The molecular weight of hydrogen is 2.016 g $mole^{-1}$. Unless otherwise specified, the mole is the gram-mole; the calorie is the thermochemical calorie; and the joule is the absolute joule.

Conversion Factors for Table 6-7

To Convert Tabulated Value of	To	Having the Dimensions Indicated Below	Multiply by
a_0	a	m sec^{-1}	1261.1
		ft sec^{-1}	4137.5

Conversion Factors for Table 6-8

To Convert Tabulated Value of	To	Having the Dimensions Indicated Below	Multiply by
η/η_0	η	poise or g sec^{-1} cm^{-1}	8.411×10^{-5}
		kg hr^{-1} m^{-1}	3.028×10^{-2}
		slug hr^{-1} ft^{-1}	6.324×10^{-4}
		lb sec^{-1} ft^{-1}	5.652×10^{-6}
		lb hr^{-1} ft^{-1}	2.035×10^{-2}

Conversion Factors for Table 6-9

To Convert Tabulated Value of	To	Having the Dimensions Indicated Below	Multiply by
k/k_0	k	cal cm^{-1} sec^{-1} $^oK^{-1}$	4.021×10^{-4}
		Btu ft^{-1} hr^{-1} $^oR^{-1}$	9.724×10^{-2}
		watts cm^{-1} $^oK^{-1}$	1.682×10^{-3}

Table 6-c. CONVERSION FACTORS FOR THE ATOMIC HYDROGEN TABLES

Conversion Factors for Table 6-12/a

To Convert Tabulated Value of	To	Having the Dimensions Indicated Below	Multiply by
$(H^o - E_0^o)/RT_0$	$(H^o - E_0^o)$	cal $mole^{-1}$	542.821
		cal g^{-1}	538.512
		joules g^{-1}	2253.14
		Btu $(lb\ mole)^{-1}$	976.437
		Btu lb^{-1}	968.688

Conversion Factors for Table 6-12/a

To Convert Tabulated Value of	To	Having the Dimensions Indicated Below	Multiply by
C_p^o/R, S^o/R,	C_p^o, S^o,	cal $mole^{-1}$ $^oK^{-1}$ (or $^oC^{-1}$)	1.98719
		cal g^{-1} $^oK^{-1}$ (or $^oC^{-1}$)	1.97142
$-(F^o - E_0^o)/RT$	$-(F^o - E_0^o)/T$	joules g^{-1} $^oK^{-1}$ (or $^oC^{-1}$)	8.24844
		Btu $(lb\ mole)^{-1}$ $^oR^{-1}$ (or $^oF^{-1}$)	1.98588
		Btu lb^{-1} $^oR^{-1}$ (or $^oF^{-1}$)	1.97012

Table 6-1. COMPRESSIBILITY FACTOR FOR HYDROGEN $Z = PV/RT$

°K	.01 atm		.1 atm		1 atm		°R
20	.9991	6	.9909	58			36
30	.9997	1	.9967	18	.9662	183	54
40	.9998	1	.9985	7	.9845	74	72
50	.9999	1	.9992	3	.9919	36	90
60	1.0000		.9995	2	.9955	20	108
70	1.0000		.9997	2	.9975	11	126
80	1.0000		.9999		.9986	7	144
90	1.0000		.9999	1	.9993	5	162
100	1.0000		1.0000		.9998	3	180
110	1.0000		1.0000		1.0001	2	198
120	1.0000		1.0000		1.0003	1	216
130	1.0000		1.0000		1.0004	1	234
140	1.0000		1.0000	1	1.0005	1	252
150	1.0000		1.0001		1.0006		270
160	1.0000		1.0001		1.0006		288
170	1.0000		1.0001		1.0006	1	306
180	1.0000		1.0001		1.0007		324
190	1.0000		1.0001		1.0007		342
200	1.0000		1.0001		1.0007		360
210	1.0000		1.0001		1.0007		378
220	1.0000		1.0001		1.0007		396
230	1.0000		1.0001		1.0007		414
240	1.0000		1.0001		1.0007	- 1	432
250	1.0000		1.0001		1.0006		450
260	1.0000		1.0001		1.0006		468
270	1.0000		1.0001		1.0006		486
280	1.0000		1.0001		1.0006		504
290	1.0000		1.0001		1.0006		522
300	1.0000		1.0001		1.0006		540
310	1.0000		1.0001		1.0006		558
320	1.0000		1.0001		1.0006		576
330	1.0000		1.0001		1.0006	- 1	594
340	1.0000		1.0001		1.0005		612
350	1.0000		1.0001		1.0005		630
360	1.0000		1.0001		1.0005		648
370	1.0000		1.0001		1.0005		666
380	1.0000		1.0001		1.0005		684
390	1.0000		1.0001	- 1	1.0005		702
400	1.0000		1.0000		1.0005		720
410	1.0000		1.0000		1.0005		738
420	1.0000		1.0000		1.0005		756
430	1.0000		1.0000		1.0005	- 1	774
440	1.0000		1.0000		1.0004		792
450	1.0000		1.0000		1.0004		810
460	1.0000		1.0000		1.0004		828
470	1.0000		1.0000		1.0004		846
480	1.0000		1.0000		1.0004		864
490	1.0000		1.0000		1.0004		882
500	1.0000		1.0000		1.0004		900
510	1.0000		1.0000		1.0004		918
520	1.0000		1.0000		1.0004		936
530	1.0000		1.0000		1.0004		954
540	1.0000		1.0000		1.0004		972
550	1.0000		1.0000		1.0004		990
560	1.0000		1.0000		1.0004		1008
570	1.0000		1.0000		1.0004	- 1	1026
580	1.0000		1.0000		1.0003		1044
590	1.0000		1.0000		1.0003		1062
600	1.0000		1.0000		1.0003		1080

Table 6-1. COMPRESSIBILITY FACTOR FOR HYDROGEN - Cont. Z = PV/RT

°K	1 atm		4 atm		7 atm		10 atm		°R
30	.9662	183							54
40	.9845	74	.9362	313	.8853	578	.8317	869	72
50	.9919	36	.9675	147	.9431	260	.9186	378	90
60	.9955	20	.9822	79	.9691	139	.9564	196	108
70	.9975	11	.9901	45	.9830	78	.9760	112	126
80	.9986	7	.9946	27	.9908	48	.9872	68	144
90	.9993	5	.9973	19	.9956	31	.9940	43	162
100	.9998	3	.9992	9	.9987	18	.9983	28	180
110	1.0001	2	1.0001	11	1.0005	16	1.0011	19	198
120	1.0003	1	1.0012	4	1.0021	8	1.0030	13	216
130	1.0004	1	1.0016	4	1.0029	7	1.0043	9	234
140	1.0005	1	1.0020	4	1.0036	5	1.0052	6	252
150	1.0006		1.0024		1.0041	2	1.0058	4	270
160	1.0006		1.0024	1	1.0043	1	1.0062	3	288
170	1.0006	1	1.0025	3	1.0044	4	1.0065	2	306
180	1.0007		1.0028		1.0048		1.0067	1	324
190	1.0007		1.0028		1.0048		1.0068		342
200	1.0007		1.0028		1.0048		1.0068		360
210	1.0007		1.0028		1.0048		1.0068	- 1	378
220	1.0007		1.0028		1.0048		1.0067		396
230	1.0007		1.0028	- 1	1.0048	- 1	1.0067	- 1	414
240	1.0007	- 1	1.0027	- 2	1.0047	- 3	1.0066	- 1	432
250	1.0006		1.0025	- 1	1.0044		1.0065	- 1	450
260	1.0006		1.0024		1.0044	- 1	1.0064	- 1	468
270	1.0006		1.0024		1.0043	- 1	1.0063	- 2	486
280	1.0006		1.0024		1.0042		1.0061	- 1	504
290	1.0006		1.0024		1.0042		1.0060	- 1	522
300	1.0006		1.0024		1.0042	- 1	1.0059	- 1	540
310	1.0006		1.0024		1.0041		1.0058	- 1	558
320	1.0006		1.0024	- 1	1.0041	- 1	1.0057	- 1	576
330	1.0006	- 1	1.0023	- 2	1.0040	- 3	1.0056	- 2	594
340	1.0005		1.0021	- 1	1.0037	- 1	1.0054	- 1	612
350	1.0005		1.0020		1.0036		1.0053	- 1	630
360	1.0005		1.0020		1.0036	- 1	1.0052	- 1	648
370	1.0005		1.0020		1.0035		1.0051	- 1	666
380	1.0005		1.0020		1.0035	- 1	1.0050	- 1	684
390	1.0005		1.0020		1.0034		1.0049	- 1	702
400	1.0005		1.0020		1.0034		1.0048	- 1	720
410	1.0005		1.0020	- 1	1.0034	- 1	1.0047	- 1	738
420	1.0005		1.0019		1.0033		1.0046		756
430	1.0005	- 1	1.0019	- 2	1.0033	- 3	1.0046	- 1	774
440	1.0004		1.0017	- 1	1.0030		1.0045	- 1	792
450	1.0004		1.0016		1.0030	- 1	1.0044	- 1	810
460	1.0004		1.0016		1.0029		1.0043	- 1	828
470	1.0004		1.0016		1.0029	- 1	1.0042	- 1	846
480	1.0004		1.0016		1.0028		1.0041	- 1	864
490	1.0004		1.0016		1.0028		1.0040		882
500	1.0004		1.0016		1.0028		1.0040		900
510	1.0004		1.0016		1.0028		1.0040	- 1	918
520	1.0004		1.0016		1.0028	- 1	1.0039	- 1	936
530	1.0004		1.0016		1.0027	- 1	1.0038	- 1	954
540	1.0004		1.0016	- 1	1.0026		1.0037	- 1	972
550	1.0004		1.0015		1.0026		1.0036		990
560	1.0004		1.0015		1.0026		1.0036		1008
570	1.0004	- 1	1.0015	- 2	1.0025	- 1	1.0036	- 1	1026
580	1.0003		1.0013		1.0024		1.0035		1044
590	1.0003		1.0013	- 1	1.0023		1.0035	- 1	1062
600	1.0003		1.0012		1.0023		1.0034		1080

°K	10 atm		40 atm		70 atm		100 atm		°R
40	.8317	869							72
50	.9186	378							90
60	.9564	196	.8757	581	.8700	661	.9395	436	108
70	.9760	112	.9338	344	.9361	421	.9831	343	126
80	.9872	68	.9682	212	.9782	268	1.0174	233	144
90	.9940	43	.9894	135	1.0050	172	1.0407	153	162
100	.9983	28	1.0029	88	1.0222	110	1.0560	103	180
110	1.0011	19	1.0117	59	1.0332	73	1.0663	63	198
120	1.0030	13	1.0176	40	1.0405	52	1.0726	39	216
130	1.0043	9	1.0216	27	1.0457	31	1.0765	21	234
140	1.0052	6	1.0243	17	1.0488	19	1.0786	10	252
150	1.0058	4	1.0260	11	1.0507	9	1.0796	2	270
160	1.0062	3	1.0271	8	1.0516	6	1.0798	- 4	288
170	1.0065	2	1.0279	4	1.0522	1	1.0794	- 9	306
180	1.0067	1	1.0283	1	1.0523	- 4	1.0785	- 12	324
190	1.0068		1.0284	- 1	1.0519	- 6	1.0773	- 13	342
200	1.0068		1.0283	- 2	1.0513	- 7	1.0760	- 15	360
210	1.0068	- 1	1.0281	- 5	1.0506	- 9	1.0745	- 15	378
220	1.0067		1.0276	- 2	1.0497	- 8	1.0730	- 16	396
230	1.0067	- 1	1.0274	- 5	1.0489	- 9	1.0714	- 16	414
240	1.0066	- 1	1.0269	- 5	1.0480	- 11	1.0698	- 16	432
250	1.0065	- 1	1.0264	- 5	1.0469	- 10	1.0682	- 15	450
260	1.0064	- 1	1.0259	- 4	1.0459	- 9	1.0667	- 16	468
270	1.0063	- 2	1.0255	- 8	1.0450	- 11	1.0651	- 15	486
280	1.0061	- 1	1.0247	- 5	1.0439	- 10	1.0636	- 15	504
290	1.0060	- 1	1.0242	- 4	1.0429	- 9	1.0621	- 14	522
300	1.0059	- 1	1.0238	- 4	1.0420	- 8	1.0607	- 13	540
310	1.0058	- 1	1.0234	- 5	1.0412	- 10	1.0594	- 15	558
320	1.0057	- 1	1.0229	- 4	1.0402	- 7	1.0579	- 13	576
330	1.0056	- 2	1.0225	- 8	1.0395	- 11	1.0566	- 13	594
340	1.0054	- 1	1.0217	- 4	1.0384	- 8	1.0553	- 12	612
350	1.0053	- 1	1.0213	- 4	1.0376	- 9	1.0541	- 12	630
360	1.0052	- 1	1.0209	- 4	1.0367	- 6	1.0529	- 11	648
370	1.0051	- 1	1.0205	- 4	1.0361	- 8	1.0518	- 11	666
380	1.0050	- 1	1.0201	- 4	1.0353	- 7	1.0507	- 11	684
390	1.0049	- 1	1.0197	- 4	1.0346	- 7	1.0496	- 10	702
400	1.0048	- 1	1.0193	- 3	1.0339	- 7	1.0486	- 10	720
410	1.0047	- 1	1.0190	- 5	1.0332	- 7	1.0476	- 10	738
420	1.0046		1.0185	- 1	1.0325	- 4	1.0466	- 9	756
430	1.0046	- 1	1.0184	- 4	1.0321	- 7	1.0457	- 9	774
440	1.0045	- 1	1.0180	- 4	1.0314	- 7	1.0448	- 9	792
450	1.0044	- 1	1.0176	- 4	1.0307	- 6	1.0439	- 8	810
460	1.0043	- 1	1.0172	- 4	1.0301	- 6	1.0431	- 8	828
470	1.0042	- 1	1.0168	- 3	1.0295	- 6	1.0423	- 8	846
480	1.0041	- 1	1.0165	- 4	1.0289	- 6	1.0415	- 8	864
490	1.0040		1.0161	- 1	1.0283	- 3	1.0407	- 7	882
500	1.0040		1.0160	- 1	1.0280	- 4	1.0400	- 8	900
510	1.0040	- 1	1.0159	- 4	1.0276	- 5	1.0392	- 7	918
520	1.0039	- 1	1.0155	- 3	1.0271	- 6	1.0385	- 7	936
530	1.0038	- 1	1.0152	- 4	1.0265	- 5	1.0378	- 6	954
540	1.0037	- 1	1.0148	- 3	1.0260	- 5	1.0372	- 6	972
550	1.0036		1.0145	- 1	1.0255	- 3	1.0366	- 6	990
560	1.0036		1.0144	- 1	1.0252	- 3	1.0360	- 6	1008
570	1.0036	- 1	1.0143	- 3	1.0249	- 5	1.0354	- 6	1026
580	1.0035		1.0140	- 1	1.0244	- 3	1.0348	- 6	1044
590	1.0035	- 1	1.0139	- 3	1.0241	- 4	1.0342	- 5	1062
600	1.0034		1.0136		1.0237		1.0337		1080

Table 6-2. DENSITY OF HYDROGEN ρ/ρ_0

°K	.01 atm		.1 atm		1 atm		°R
20	.13679	-4565	1.3792	-4651			36
30	.091137	-22791	.91411	-22976	9.4297	-24889	54
40	.068346	-13675	.68435	-13725	6.9408	-14296	72
50	.054671	-9116	.54710	-9132	5.5112	-9351	90
60	.045555	-6508	.45578	-6619	4.5761	-6616	108
70	.039047	-4881	.39059	-4889	3.9145	-4931	126
80	.034166	-3796	.34170	-3797	3.4214	-3823	144
90	.030370	-3037	.30373	-3040	3.0391	-3053	162
100	.027333	-2485	.27333	-2485	2.7338	-2492	180
110	.024848	-2071	.24848	-2071	2.4846	-2075	198
120	.022777	-1752	.22777	-1752	2.2771	-1754	216
130	.021025	-1502	.21025	-1502	2.1017	-1503	234
140	.019523	-1301	.19523	-1303	1.9514	-1303	252
150	.018222	-1139	.18220	-1139	1.8211	-1138	270
160	.017083	-1005	.17081	-1004	1.7073	-1004	288
170	.016078	-893	.16077	-894	1.6069	-895	306
180	.015185	-799	.15183	-799	1.5174	-798	324
190	.014386	-720	.14384	-719	1.4376	-719	342
200	.013666	-650	.13665	-651	1.3657	-650	360
210	.013016	-592	.13014	-591	1.3007	-592	378
220	.012424	-540	.12423	-540	1.2415	-539	396
230	.011884	-495	.11883	-495	1.1876	-495	414
240	.011389	-456	.11388	-456	1.1381	-454	432
250	.010933	-420	.10932	-420	1.0927	-421	450
260	.010513	-390	.10512	-390	1.0506	-389	468
270	.010123	-361	.10122	-361	1.0117	-361	486
280	.009762	-337	.09761	-337	.9756	-336	504
290	.009425	-314	.09424	-314	.9420	-314	522
300	.009111	-294	.09110	-294	.9106	-294	540
310	.008817	-275	.08816	-275	.8812	-276	558
320	.008542	-259	.08541	-259	.8536	-258	576
330	.008283	-244	.08282	-244	.8278	-243	594
340	.008039	-230	.08038	-229	.8035	-229	612
350	.007809	-216	.07809	-217	.7806	-217	630
360	.007593	-206	.07592	-205	.7589	-205	648
370	.007387	-194	.07387	-195	.7384	-195	666
380	.007193	-185	.07192	-184	.7189	-184	684
390	.007008	-175	.07008	-175	.7005	-175	702
400	.006833	-166	.06833	-166	.6830	-167	720
410	.006667	-159	.06667	-159	.6663	-158	738
420	.006508	-151	.06508	-151	.6505	-149	756
430	.006357	-145	.06357	-145	.6356	-146	774
440	.006212	-138	.06212	-138	.6210	-138	792
450	.006074	-132	.06074	-132	.6072	-132	810
460	.005942	-126	.05942	-126	.5940	-127	828
470	.005816	-122	.05816	-122	.5813	-121	846
480	.005694	-116	.05694	-116	.5692	-116	864
490	.005578	-111	.05578	-111	.5576	-112	882
500	.005467	-108	.05467	-108	.5464	-107	900
510	.005359	-103	.05359	-103	.5357	-103	918
520	.005256	-99	.05256	-99	.5254	-99	936
530	.005157	-95	.05157	-95	.5155	-95	954
540	.005062	-92	.05062	-92	.5060	-92	972
550	.004970	-89	.04970	-89	.4968	-89	990
560	.004881	-86	.04881	-86	.4879	-86	1008
570	.004795	-82	.04795	-82	.4793	-82	1026
580	.004713	-80	.04713	-80	.4711	-80	1044
590	.004633	-77	.04633	-77	.4631	-77	1062
600	.004556		.04556		.4554		1080

°K	1 atm		4 atm		7 atm		10 atm		°R
30	9.4297	-24889							54
40	6.9408	-14296	29.195	-6595	54.029	-13455	82.16	-2265	72
50	5.5112	- 9351	22.600	-4048	40.574	- 7669	59.51	-1188	90
60	4.5761	- 6616	18.552	-2777	32.905	- 5100	47.632	- 7625	108
70	3.9145	- 4931	15.775	-2035	27.805	- 3667	40.007	- 5398	126
80	3.4214	- 3823	13.740	-1559	24.138	- 2816	34.609	- 4056	144
90	3.0391	- 3053	12.181	-1239	21.352	- 2194	30.553	- 3174	162
100	2.7338	- 2492	10.942	-1004	19.158	- 1773	27.379	- 2558	180
110	2.4846	- 2075	9.938	- 838	17.385	- 1475	24.821	- 2112	198
120	2.2771	- 1754	9.100	- 703	15.910	- 1235	22.709	- 1774	216
130	2.1017	- 1503	8.397	- 603	14.675	- 1058	20.935	- 1513	234
140	1.9514	- 1303	7.794	- 523	13.617	- 914	19.422	- 1305	252
150	1.8211	- 1138	7.271	- 454	12.703	- 796	18.117	- 1139	270
160	1.7073	- 1004	6.817	- 402	11.907	- 702	16.978	- 1004	288
170	1.6069	- 895	6.415	- 358	11.205	- 627	15.974	- 890	306
180	1.5174	- 798	6.057	- 319	10.578	- 556	15.084	- 795	324
190	1.4376	- 719	5.738	- 287	10.022	- 501	14.289	- 715	342
200	1.3657	- 650	5.451	- 259	9.521	- 454	13.574	- 646	360
210	1.3007	- 592	5.192	- 236	9.067	- 412	12.928	- 587	378
220	1.2415	- 539	4.956	- 216	8.655	- 376	12.341	- 536	396
230	1.1876	- 495	4.740	- 197	8.279	- 344	11.805	- 491	414
240	1.1381	- 454	4.543	- 181	7.935	- 315	11.314	- 451	432
250	1.0927	- 421	4.362	- 167	7.620	- 293	10.863	- 417	450
260	1.0506	- 389	4.195	- 155	7.327	- 271	10.446	- 386	468
270	1.0117	- 361	4.040	- 145	7.056	- 251	10.060	- 357	486
280	.9756	- 336	3.895	- 134	6.805	- 235	9.703	- 334	504
290	.9420	- 314	3.761	- 125	6.570	- 219	9.369	- 311	522
300	.9106	- 294	3.6356	- 1173	6.351	- 204	9.058	- 292	540
310	.8812	- 276	3.5183	- 1099	6.147	- 192	8.766	- 273	558
320	.8536	- 258	3.4084	- 1030	5.955	- 180	8.493	- 256	576
330	.8278	- 243	3.3054	- 966	5.775	- 168	8.237	- 241	594
340	.8035	- 229	3.2088	- 913	5.607	- 160	7.996	- 228	612
350	.7806	- 217	3.1175	- 866	5.447	- 151	7.768	- 215	630
360	.7589	- 205	3.0309	- 819	5.296	- 143	7.553	- 203	648
370	.7384	- 195	2.9490	- 776	5.153	- 136	7.350	- 193	666
380	.7189	- 184	2.8714	- 737	5.017	- 128	7.157	- 183	684
390	.7005	- 175	2.7977	- 699	4.889	- 122	6.974	- 173	702
400	.6830	- 167	2.7278	- 665	4.767	- 116	6.801	- 166	720
410	.6663	- 158	2.6613	- 631	4.651	- 111	6.635	- 157	738
420	.6505	- 149	2.5982	- 605	4.540	- 105	6.478	- 151	756
430	.6356	- 146	2.5377	- 571	4.435	- 100	6.327	- 143	774
440	.6210	- 138	2.4806	- 549	4.335	- 96	6.184	- 137	792
450	.6072	- 132	2.4257	- 528	4.239	- 92	6.047	- 130	810
460	.5940	- 127	2.3729	- 504	4.147	- 88	5.917	- 126	828
470	.5813	- 121	2.3225	- 484	4.059	- 84	5.791	- 120	846
480	.5692	- 116	2.2741	- 464	3.975	- 81	5.671	- 115	864
490	.5576	- 112	2.2277	- 446	3.894	- 78	5.556	- 111	882
500	.5464	- 107	2.1831	- 428	3.8159	- 749	5.445	- 107	900
510	.5357	- 103	2.1403	- 412	3.7410	- 719	5.338	- 102	918
520	.5254	- 99	2.0991	- 396	3.6691	- 689	5.236	- 98	936
530	.5155	- 95	2.0595	- 381	3.6002	- 663	5.138	- 95	954
540	.5060	- 92	2.0214	- 366	3.5339	- 642	5.043	- 91	972
550	.4968	- 89	1.9848	- 354	3.4697	- 620	4.952	- 89	990
560	.4879	- 86	1.9494	- 342	3.4077	- 595	4.863	- 85	1008
570	.4793	- 82	1.9152	- 326	3.3482	- 574	4.778	- 82	1026
580	.4711	- 80	1.8826	- 320	3.2908	- 554	4.696	- 79	1044
590	.4631	- 77	1.8506	- 306	3.2354	- 539	4.617	- 77	1062
600	.4554		1.8200		3.1815		4.540		1080

°K	10 atm		40 atm		70 atm		100 atm		°R
40	82.16	-2265							72
50	59.51	-1188							90
60	47.632	- 7625	208.08	-4082	366.53	-7455	484.88	-8770	108
70	40.007	- 5398	167.26	-2611	291.98	-4749	397.18	-6136	126
80	34.609	- 4056	141.15	-1837	244.49	-3296	335.82	-4400	144
90	30.553	- 3174	122.78	-1377	211.53	-2436	291.82	-3299	162
100	27.379	- 2558	109.01	-1077	187.17	-1883	258.83	-2580	180
110	24.821	- 2112	98.24	- 871	168.34	-1511	233.03	-2067	198
120	22.709	- 1774	89.53	- 721	153.23	-1249	212.36	-1705	216
130	20.935	- 1513	82.32	- 608	140.74	-1044	195.31	-1430	234
140	19.422	- 1305	76.24	- 520	130.30	- 890	181.01	-1223	252
150	18.117	- 1139	71.04	- 451	121.40	- 769	168.78	-1057	270
160	16.978	- 1004	66.53	- 396	113.71	- 675	158.21	- 926	288
170	15.974	- 890	62.57	- 350	106.96	- 595	148.95	- 815	306
180	15.084	- 795	59.07	- 312	101.01	- 528	140.80	- 726	324
190	14.289	- 715	55.95	- 279	95.73	- 473	133.54	- 653	342
200	13.574	- 646	53.16	- 252	91.00	- 428	127.01	- 588	360
210	12.928	- 587	50.64	- 228	86.72	- 387	121.13	- 534	378
220	12.341	- 536	48.36	- 209	82.85	- 354	115.79	- 487	396
230	11.805	- 491	46.27	- 191	79.31	- 324	110.92	- 446	414
240	11.314	- 451	44.36	- 175	76.07	- 297	106.46	- 411	432
250	10.863	- 417	42.61	- 162	73.10	- 274	102.35	- 380	450
260	10.446	- 386	40.99	- 150	70.36	- 255	98.55	- 350	468
270	10.060	- 357	39.49	- 138	67.81	- 235	95.05	- 327	486
280	9.703	- 334	38.11	- 130	65.46	- 220	91.78	- 304	504
290	9.369	- 311	36.81	- 121	63.26	- 205	88.74	- 284	522
300	9.058	- 292	35.596	- 1135	61.21	- 193	85.90	- 267	540
310	8.766	- 273	34.461	- 1060	59.28	- 180	83.23	- 249	558
320	8.493	- 256	33.401	- 1000	57.48	- 170	80.74	- 235	576
330	8.237	- 241	32.401	- 928	55.78	- 159	78.39	- 221	594
340	7.996	- 228	31.473	- 887	54.19	- 151	76.18	- 209	612
350	7.768	- 215	30.586	- 838	52.68	- 141	74.09	- 198	630
360	7.553	- 203	29.748	- 793	51.27	- 136	72.11	- 187	648
370	7.350	- 193	28.955	- 751	49.91	- 128	70.24	- 178	666
380	7.157	- 183	28.204	- 712	48.63	- 121	68.46	- 169	684
390	6.974	- 173	27.492	- 677	47.42	- 113	66.77	- 160	702
400	6.801	- 166	26.815	- 646	46.29	- 112	65.17	- 153	720
410	6.635	- 157	26.169	- 611	45.17	- 105	63.64	- 146	738
420	6.478	- 151	25.558	- 592	44.12	- 101	62.18	- 139	756
430	6.327	- 143	24.966	- 558	43.11	- 95	60.79	- 133	774
440	6.184	- 137	24.408	- 533	42.16	- 91	59.46	- 127	792
450	6.047	- 130	23.875	- 510	41.25	- 87	58.19	- 123	810
460	5.917	- 126	23.365	- 488	40.38	- 84	56.96	- 116	828
470	5.791	- 120	22.877	- 470	39.54	- 80	55.80	- 112	846
480	5.671	- 115	22.407	- 448	38.74	- 77	54.68	- 108	864
490	5.556	- 111	21.959	- 437	37.97	- 75	53.60	- 104	882
500	5.445	- 107	21.522	- 420	37.223	- 716	52.56	- 99	900
510	5.338	- 102	21.102	- 398	36.507	- 684	51.57	- 95	918
520	5.236	- 98	20.704	- 385	35.823	- 656	50.62	- 93	936
530	5.138	- 95	20.319	- 368	35.167	- 634	49.69	- 89	954
540	5.043	- 91	19.951	- 357	34.533	- 611	48.80	- 86	972
550	4.952	- 89	19.594	- 348	33.922	- 596	47.94	- 83	990
560	4.863	- 85	19.246	- 336	33.326	- 575	47.11	- 80	1008
570	4.778	- 82	18.910	- 320	32.751	- 549	46.31	- 77	1026
580	4.696	- 79	18.590	- 314	32.202	- 537	45.54	- 74	1044
590	4.617	- 77	18.276	- 299	31.665	- 515	44.80	- 73	1062
600	4.540		17.977		31.150		44.07		1080

Table 6-3. SPECIFIC HEAT OF HYDROGEN C_p/R

°K	0 atm		1 atm		10 atm		100 atm		°R
20	2.500								36
30	2.500	1	2.628	-64					54
40	2.501	4	2.564	-21	3.463	-516			72
50	2.505	14	2.543	1	2.947	-167			90
60	2.519	28	2.544	21	2.780	- 48	3.957	-171	108
70	2.547	44	2.565	40	2.732	- 9	3.786	-222	126
80	2.591	57	2.605	53	2.723	24	3.564	-198	144
90	2.648	66	2.658	64	2.747	43	3.366	- 71	162
100	2.714	71	2.722	69	2.790	55	3.295	- 44	180
110	2.785	72	2.791	71	2.845	60	3.251	- 9	198
120	2.857	70	2.862	69	2.905	62	3.242	2	216
130	2.927	66	2.931	65	2.967	59	3.244	20	234
140	2.993	60	2.996	60	3.026	57	3.264	29	252
150	3.053	55	3.056	55	3.083	52	3.293	33	270
160	3.108	50	3.111	50	3.135	48	3.326	29	288
170	3.158	46	3.161	45	3.183	43	3.355	22	306
180	3.204	40	3.206	40	3.226	37	3.377	19	324
190	3.244	36	3.246	36	3.263	33	3.396	17	342
200	3.280	32	3.282	31	3.296	31	3.413	20	360
210	3.312	28	3.313	28	3.327	28	3.433	21	378
220	3.340	26	3.341	26	3.355	24	3.454	18	396
230	3.366	21	3.367	21	3.379	20	3.472	14	414
240	3.387	20	3.388	20	3.399	18	3.486	10	432
250	3.407	17	3.408	17	3.417	16	3.496	8	450
260	3.424	14	3.425	14	3.433	13	3.504	6	468
270	3.438	12	3.439	12	3.446	12	3.510	6	486
280	3.450	10	3.451	11	3.458	10	3.516	5	504
290	3.460	9	3.462	8	3.468	8	3.521	5	522
300	3.469	14	3.470	14	3.476	13	3.526	6	540
320	3.483	11	3.484	11	3.489	10	3.532	4	576
340	3.494	7	3.495	7	3.499	7	3.536	3	612
360	3.501	6	3.502	6	3.506	4	3.539		648
380	3.507	3	3.508	3	3.510	4	3.539		684
400	3.510	3	3.511	3	3.514	2	3.539		720
420	3.513	2	3.514	2	3.516	2	3.539	- 1	756
440	3.515	1	3.516	1	3.518	1	3.538		792
460	3.516	2	3.517	1	3.519	1	3.538	- 1	828
480	3.518	1	3.518	1	3.520	1	3.537	- 1	864
500	3.519	2	3.519	2	3.521	2	3.536		900
520	3.521	1	3.521	1	3.523	1	3.536		936
540	3.522	2	3.522	2	3.524	2	3.536		972
560	3.524	1	3.524	1	3.526	1	3.536		1008
580	3.525	2	3.525	2	3.527	2	3.536		1044
600	3.527		3.527		3.529		3.536		1080

Table 6-4. ENTHALPY OF HYDROGEN* $(H-E_0^0)/RT_0$

°K	.01 atm		.1 atm		1 atm		°R
60	1.0175	927	1.0172	927	1.0142	934	108
70	1.1102	940	1.1099	941	1.1076	945	126
80	1.2042	958	1.2040	959	1.2021	963	144
90	1.3000	981	1.2999	981	1.2984	984	162
100	1.3981	1007	1.3980	1007	1.3968	1009	180
110	1.4988	1032	1.4987	1033	1.4977	1035	198
120	1.6020	1059	1.6020	1059	1.6012	1060	216
130	1.7079	1084	1.7079	1084	1.7072	1086	234
140	1.8163	1107	1.8163	1107	1.8158	1108	252
150	1.9270	1128	1.9270	1128	1.9266	1128	270
160	2.0398	1147	2.0398	1147	2.0394	1149	288
170	2.1545	1165	2.1545	1165	2.1543	1165	306
180	2.2710	1180	2.2710	1180	2.2708	1181	324
190	2.3890	1195	2.3890	1195	2.3889	1195	342
200	2.5085	1206	2.5085	1206	2.5084	1207	360
210	2.6291	1218	2.6291	1218	2.6291	1219	378
220	2.7509	1228	2.7509	1228	2.7510	1228	396
230	2.8737	1236	2.8737	1236	2.8738	1237	414
240	2.9973	1244	2.9973	1243	2.9975	1244	432
250	3.1217	1250	3.1216	1251	3.1219	1251	450
260	3.2467	1256	3.2467	1255	3.2470	1256	468
270	3.3723	1260	3.3722	1262	3.3726	1260	486
280	3.4983	1265	3.4984	1265	3.4986	1266	504
290	3.6248	1269	3.6249	1268	3.6252	1269	522
300	3.7517	1272	3.7517	1272	3.7521	1272	540
310	3.8789	1274	3.8789	1274	3.8793	1274	558
320	4.0063	1276	4.0063	1276	4.0067	1276	576
330	4.1339	1278	4.1339	1278	4.1343	1279	594
340	4.2617	1280	4.2617	1280	4.2622	1279	612
350	4.3897	1281	4.3897	1281	4.3901	1282	630
360	4.5178	1282	4.5178	1282	4.5183	1282	648
370	4.6460	1283	4.6460	1284	4.6465	1283	666
380	4.7743	1284	4.7744	1283	4.7748	1284	684
390	4.9027	1285	4.9027	1285	4.9032	1285	702
400	5.0312	1285	5.0312	1285	5.0317	1286	720
410	5.1597	1286	5.1597	1286	5.1603	1286	738
420	5.2883	1286	5.2883	1286	5.2889	1286	756
430	5.4169	1286	5.4169	1287	5.4175	1286	774
440	5.5455	1287	5.5456	1286	5.5461	1287	792
450	5.6742	1287	5.6742	1288	5.6748	1287	810
460	5.8029	1287	5.8030	1287	5.8035	1288	828
470	5.9316	1288	5.9317	1288	5.9323	1287	846
480	6.0604	1288	6.0605	1288	6.0610	1288	864
490	6.1892	1288	6.1893	1288	6.1898	1289	882
500	6.3180	1288	6.3181	1288	6.3187	1288	900
510	6.4468	1289	6.4469	1289	6.4475	1289	918
520	6.5757	1289	6.5758	1288	6.5764	1289	936
530	6.7046	1289	6.7046	1290	6.7053	1289	954
540	6.8335	1290	6.8336	1289	6.8342	1289	972
550	6.9625	1290	6.9625	1290	6.9631	1290	990
560	7.0915	1290	7.0915	1290	7.0921	1291	1008
570	7.2205	1290	7.2205	1291	7.2212	1290	1026
580	7.3495	1291	7.3496	1290	7.3502	1291	1044
590	7.4786	1291	7.4786	1292	7.4793	1291	1062
600	7.6077		7.6078		7.6084		1080

* The enthalpy function is divided here by a constant RT_0 where T_0 = 273.16°K (491.688°R).

°K	1 atm		10 atm		100 atm		°R
60	1.0142	934	.9833	1008	.7818	1416	108
70	1.1076	945	1.0841	996	.9234	1343	126
80	1.2021	963	1.1837	1001	1.0577	1263	144
90	1.2984	984	1.2838	1014	1.1840	1219	162
100	1.3968	1009	1.3852	1035	1.3059	1200	180
110	1.4977	1035	1.4887	1049	1.4259	1190	198
120	1.6012	1060	1.5936	1074	1.5449	1183	216
130	1.7072	1086	1.7010	1098	1.6632	1193	234
140	1.8158	1108	1.8108	1119	1.7825	1203	252
150	1.9266	1128	1.9227	1138	1.9028	1206	270
160	2.0394	1149	2.0365	1157	2.0234	1224	288
170	2.1543	1165	2.1522	1173	2.1458	1232	306
180	2.2708	1181	2.2695	1187	2.2690	1249	324
190	2.3889	1195	2.3882	1201	2.3939	1239	342
200	2.5084	1207	2.5083	1212	2.5178	1251	360
210	2.6291	1219	2.6295	1224	2.6429	1263	378
220	2.7510	1228	2.7519	1232	2.7692	1270	396
230	2.8738	1237	2.8751	1242	2.8962	1274	414
240	2.9975	1244	2.9993	1247	3.0236	1277	432
250	3.1219	1251	3.1240	1255	3.1513	1279	450
260	3.2470	1256	3.2495	1257	3.2792	1284	468
270	3.3726	1260	3.3752	1265	3.4076	1287	486
280	3.4986	1266	3.5017	1268	3.5363	1288	504
290	3.6252	1269	3.6285	1271	3.6651	1290	522
300	3.7521	1272	3.7556	1274	3.7941	1291	540
310	3.8793	1274	3.8830	1276	3.9232	1293	558
320	4.0067	1276	4.0106	1278	4.0525	1294	576
330	4.1343	1279	4.1384	1280	4.1819	1295	594
340	4.2622	1279	4.2664	1282	4.3114	1295	612
350	4.3901	1282	4.3946	1283	4.4409	1296	630
360	4.5183	1282	4.5229	1284	4.5705	1296	648
370	4.6465	1283	4.6513	1284	4.7001	1295	666
380	4.7748	1284	4.7797	1285	4.8296	1296	684
390	4.9032	1285	4.9082	1286	4.9592	1295	702
400	5.0317	1286	5.0368	1286	5.0887	1296	720
410	5.1603	1286	5.1654	1287	5.2183	1295	738
420	5.2889	1286	5.2941	1287	5.3478	1295	756
430	5.4175	1286	5.4228	1288	5.4773	1294	774
440	5.5461	1287	5.5516	1288	5.6067	1296	792
450	5.6748	1287	5.6804	1287	5.7363	1296	810
460	5.8035	1288	5.8091	1289	5.8659	1295	828
470	5.9323	1287	5.9380	1289	5.9954	1295	846
480	6.0610	1288	6.0669	1289	6.1249	1295	864
490	6.1898	1289	6.1958	1288	6.2544	1295	882
500	6.3187	1288	6.3246	1289	6.3839	1294	900
510	6.4475	1289	6.4535	1289	6.5133	1294	918
520	6.5764	1289	6.5824	1290	6.6427	1294	936
530	6.7053	1289	6.7114	1290	6.7721	1294	954
540	6.8342	1289	6.8404	1290	6.9015	1295	972
550	6.9631	1290	6.9694	1290	7.0310	1296	990
560	7.0921	1291	7.0984	1290	7.1606	1294	1008
570	7.2212	1290	7.2274	1291	7.2900	1294	1026
580	7.3502	1291	7.3565	1291	7.4194	1295	1044
590	7.4793	1291	7.4856	1291	7.5489	1295	1062
600	7.6084		7.6147		7.6784		1080

* The enthalpy function is divided here by a constant RT_0 where T_0 = 273.16°K (491.688°R).

°K	.01 atm		.1 atm		1 atm		°R
60	15.554	391	13.251	390	10.938	394	108
70	15.945	342	13.641	343	11.332	344	126
80	16.287	308	13.984	308	11.676	310	144
90	16.595	283	14.292	283	11.986	283	162
100	16.878	263	14.575	263	12.269	263	180
110	17.141	245	14.838	245	12.532	246	198
120	17.386	231	15.083	231	12.778	231	216
130	17.617	219	15.314	219	13.009	220	234
140	17.836	209	15.533	209	13.229	209	252
150	18.045	199	15.742	199	13.438	199	270
160	18.244	190	15.941	190	13.637	190	288
170	18.434	182	16.131	182	13.827	182	306
180	18.616	174	16.313	174	14.009	175	324
190	18.790	168	16.487	168	14.184	168	342
200	18.958	160	16.655	160	14.352	160	360
210	19.118	155	16.815	155	14.512	155	378
220	19.273	148	16.970	149	14.667	149	396
230	19.421	145	17.119	144	14.816	144	414
240	19.566	138	17.263	138	14.960	138	432
250	19.704	134	17.401	134	15.098	134	450
260	19.838	129	17.535	130	15.232	130	468
270	19.967	126	17.665	125	15.362	125	486
280	20.093	121	17.790	121	15.487	121	504
290	20.214	117	17.911	118	15.608	118	522
300	20.331	114	18.029	114	15.726	114	540
310	20.445	111	18.143	111	15.840	111	558
320	20.556	108	18.254	107	15.951	107	576
330	20.664	104	18.361	104	16.058	104	594
340	20.768	101	18.465	101	16.162	101	612
350	20.869	98	18.566	99	16.263	99	630
360	20.967	96	18.665	96	16.362	96	648
370	21.063	94	18.761	93	16.458	94	666
380	21.157	91	18.854	91	16.552	91	684
390	21.248	89	18.945	89	16.643	88	702
400	21.337	87	19.034	87	16.731	87	720
410	21.424	84	19.121	85	16.818	85	738
420	21.508	83	19.206	83	16.903	83	756
430	21.591	80	19.289	80	16.986	80	774
440	21.671	79	19.369	79	17.066	79	792
450	21.750	78	19.448	77	17.145	78	810
460	21.828	76	19.525	76	17.223	76	828
470	21.904	73	19.601	74	17.299	73	846
480	21.977	73	19.675	72	17.372	72	864
490	22.050	71	19.747	71	17.444	71	882
500	22.121	70	19.818	70	17.515	70	900
510	22.191	69	19.888	69	17.585	70	918
520	22.260	67	19.957	67	17.655	67	936
530	22.327	65	20.024	66	17.722	65	954
540	22.392	65	20.090	65	17.787	65	972
550	22.457	63	20.155	63	17.852	63	990
560	22.520	63	20.218	62	17.915	62	1008
570	22.583	61	20.280	61	17.977	61	1026
580	22.644	60	20.341	60	18.038	60	1044
590	22.704	60	20.401	60	18.098	60	1062
600	22.764		20.461		18.158		1080

Table 6-5. ENTROPY OF HYDROGEN - Cont. S/R

°K	1 atm		10 atm		100 atm		°R
60	10.938	394	8.535	425	5.557	601	108
70	11.332	344	8.960	364	6.158	484	126
80	11.676	310	9.324	321	6.642	407	144
90	11.986	283	9.645	292	7.049	351	162
100	12.269	263	9.937	269	7.400	313	180
110	12.532	246	10.206	250	7.713	283	198
120	12.778	231	10.456	234	7.996	258	216
130	13.009	220	10.690	223	8.254	242	234
140	13.229	209	10.913	210	8.496	225	252
150	13.438	199	11.123	201	8.721	214	270
160	13.637	190	11.324	192	8.935	203	288
170	13.827	182	11.516	183	9.138	193	306
180	14.009	175	11.699	175	9.331	183	324
190	14.184	168	11.874	169	9.514	174	342
200	14.352	160	12.043	161	9.688	167	360
210	14.512	155	12.204	155	9.855	160	378
220	14.667	149	12.359	150	10.015	154	396
230	14.816	144	12.509	144	10.169	148	414
240	14.960	138	12.653	139	10.317	142	432
250	15.098	134	12.792	134	10.459	137	450
260	15.232	130	12.926	130	10.596	133	468
270	15.362	125	13.056	126	10.729	128	486
280	15.487	121	13.182	121	10.857	124	504
290	15.608	118	13.303	118	10.981	119	522
300	15.726	114	13.421	114	11.100	116	540
310	15.840	111	13.535	111	11.216	112	558
320	15.951	107	13.646	108	11.328	109	576
330	16.058	104	13.754	104	11.437	105	594
340	16.162	101	13.858	102	11.542	103	612
350	16.263	99	13.960	98	11.645	99	630
360	16.362	96	14.058	96	11.744	97	648
370	16.458	94	14.154	94	11.841	95	666
380	16.552	91	14.248	91	11.936	92	684
390	16.643	88	14.339	89	12.028	89	702
400	16.731	87	14.428	87	12.117	88	720
410	16.818	85	14.515	85	12.205	85	738
420	16.903	83	14.600	83	12.290	83	756
430	16.986	80	14.683	80	12.373	81	774
440	17.066	79	14.763	79	12.454	80	792
450	17.145	78	14.842	77	12.534	78	810
460	17.223	76	14.919	76	12.612	76	828
470	17.299	73	14.995	74	12.688	74	846
480	17.372	72	15.069	73	12.762	73	864
490	17.444	71	15.142	71	12.835	71	882
500	17.515	70	15.213	70	12.906	71	900
510	17.585	70	15.283	69	12.977	69	918
520	17.655	67	15.352	67	13.046	67	936
530	17.722	65	15.419	65	13.113	66	954
540	17.787	65	15.484	65	13.179	65	972
550	17.852	63	15.549	63	13.244	64	990
560	17.915	62	15.612	63	13.308	62	1008
570	17.977	61	15.675	61	13.370	61	1026
580	18.038	60	15.736	61	13.431	61	1044
590	18.098	60	15.797	59	13.492	60	1062
600	18.158		15.856		13.552		1080

Table 6-6. SPECIFIC-HEAT RATIO OF HYDROGEN $\gamma = C_p/C_v$

°K	0 atm		1 atm		10 atm		100 atm		°R
20	1.667								36
30	1.667	-1	1.736	-36					54
40	1.666	-2	1.700	-16	2.205	-292			72
50	1.664	-6	1.684	-12	1.913	-109			90
60	1.658	-12	1.672	-17	1.804	-66	2.497	-241	108
70	1.646	-18	1.655	-21	1.738	-44	2.256	-190	126
80	1.628	-21	1.634	-23	1.694	-39	2.066	-121	144
90	1.607	-24	1.611	-24	1.655	-38	1.945	-101	162
100	1.583	-23	1.587	-24	1.617	-31	1.844	-76	180
110	1.560	-21	1.563	-22	1.586	-28	1.768	-64	198
120	1.539	-20	1.541	-20	1.558	-22	1.704	-50	216
130	1.519	-17	1.521	-18	1.536	-19	1.654	-41	234
140	1.502	-15	1.503	-15	1.517	-17	1.613	-34	252
150	1.487	-13	1.488	-13	1.500	-16	1.579	-30	270
160	1.474	-11	1.475	-11	1.484	-12	1.549	-24	288
170	1.463	-9	1.464	-9	1.472	-11	1.525	-18	306
180	1.454	-8	1.455	-9	1.461	-9	1.507	-16	324
190	1.446	-7	1.446	-7	1.452	-8	1.491	-12	342
200	1.439	-6	1.439	-6	1.444	-7	1.479	-11	360
210	1.433	-6	1.433	-5	1.437	-6	1.468	-9	378
220	1.427	-4	1.428	-5	1.431	-5	1.459	-9	396
230	1.423	-4	1.423	-4	1.426	-4	1.450	-8	414
240	1.419	-4	1.419	-3	1.422	-4	1.442	-6	432
250	1.415	-2	1.416	-3	1.418	-2	1.436	-5	450
260	1.413	-3	1.413	-3	1.416	-3	1.431	-4	468
270	1.410	-2	1.410	-2	1.413	-3	1.427	-4	486
280	1.408	-2	1.408	-2	1.410	-2	1.423	-3	504
290	1.406	-1	1.406	-1	1.408	-2	1.420	-3	522
300	1.405	-3	1.405	-3	1.406	-3	1.417	-4	540
320	1.402	-1	1.402	-1	1.403	-2	1.413	-4	576
340	1.401	-1	1.401	-1	1.401	-1	1.409	-2	612
360	1.400	-1	1.400	-1	1.400	-1	1.407	-3	648
380	1.399	-1	1.399	-1	1.399	-1	1.404	-1	684
400	1.398		1.398		1.398		1.403	-1	720
420	1.398		1.398	-1	1.398		1.402	-1	756
440	1.398	-1	1.397		1.398		1.401	-1	792
460	1.397		1.397		1.398	-1	1.400	-1	828
480	1.397		1.397		1.397		1.399	-1	864
500	1.397		1.397		1.397		1.398		900
520	1.397		1.397		1.397		1.398	-1	936
540	1.397	-1	1.397	-1	1.397		1.397		972
560	1.396		1.396		1.397	-1	1.397	-1	1008
580	1.396		1.396		1.396		1.396		1044
600	1.396		1.396		1.396		1.396		1080

Table 6-7. SOUND VELOCITY AT LOW FREQUENCY IN HYDROGEN a/a_0

°K	0 atm		1 atm		10 atm		100 atm		°R
20	.2940	661							36
30	.3601	556	.3549	585					54
40	.4157	489	.4134	501	.3942	632			72
50	.4646	433	.4635	444	.4574	505			90
60	.5079	388	.5079	389	.5079	408	.742	−19	108
70	.5467	345	.5468	347	.5487	365	.723	2	126
80	.5812	312	.5815	313	.5852	323	.725	18	144
90	.6124	284	.6128	285	.6175	296	.743	17	162
100	.6408	263	.6413	265	.6471	272	.760	19	180
110	.6671	248	.6678	248	.6743	252	.779	19	198
120	.6919	237	.6926	237	.6995	237	.798	19	216
130	.7156	228	.7163	228	.7232	226	.817	19	234
140	.7384	222	.7391	222	.7458	222	.836	19	252
150	.7606	215	.7613	216	.7680	217	.855	18	270
160	.7821	211	.7829	210	.7897	210	.873	18	288
170	.8032	205	.8039	206	.8107	203	.891	19	306
180	.8237	202	.8245	202	.8310	201	.910	18	324
190	.8439	199	.8447	198	.8511	200	.928	18	342
200	.8638	194	.8645	195	.8711	196	.946	18	360
210	.8832	192	.8840	192	.8907	190	.964	17	378
220	.9024	188	.9032	187	.9097	186	.981	18	396
230	.9212	185	.9219	186	.9283	182	.999	16	414
240	.9397	182	.9405	181	.9465	182	1.015	17	432
250	.9579	180	.9586	180	.9647	177	1.032	17	450
260	.9759	178	.9766	177	.9824	18	1.049	17	468
270	.9937	175	.9943	175	1.000	18	1.066	16	486
280	1.0112	172	1.0118	17	1.018	17	1.082	16	504
290	1.0284	171	1.029	17	1.035	16	1.098	16	522
300	1.0455	334	1.046	34	1.051	35	1.114	32	540
320	1.0789	325	1.080	32	1.086	31	1.146	31	576
340	1.1114	317	1.112	32	1.117	31	1.177	30	612
360	1.1431	310	1.144	31	1.148	32	1.207	29	648
380	1.1741	303	1.175	30	1.180	30	1.236	29	684
400	1.2044	295	1.205	30	1.210	30	1.265	28	720
420	1.2339	289	1.235	28	1.240	28	1.293	28	756
440	1.2628	283	1.263	29	1.268	28	1.321	27	792
460	1.2911	276	1.292	27	1.296	28	1.348	26	828
480	1.3187	272	1.319	27	1.324	27	1.374	26	864
500	1.3459	265	1.346	27	1.351	26	1.400	26	900
520	1.3724	260	1.373	26	1.377	26	1.426	24	936
540	1.3984	255	1.399	25	1.403	25	1.450	25	972
560	1.4239	251	1.424	25	1.428	25	1.475	24	1008
580	1.4490	246	1.449	25	1.453	25	1.499	24	1044
600	1.4736		1.474		1.478		1.523		1080

Table 6-8. VISCOSITY OF HYDROGEN AT ATMOSPHERIC PRESSURE

°K	η/η_0		°R
10	.0606	693	18
20	.1299	611	36
30	.1910	548	54
40	.2458	501	72
50	.2959	460	90
60	.3419	430	108
70	.3849	406	126
80	.4255	385	144
90	.4640	366	162
100	.5006	353	180
110	.5359	339	198
120	.5698	329	216
130	.6027	319	234
140	.6346	309	252
150	.6655	302	270
160	.6957	295	288
170	.7252	289	306
180	.7541	282	324
190	.7823	277	342
200	.8100	273	360
210	.8373	268	378
220	.8641	263	396
230	.8904	260	414
240	.9164	256	432
250	.9420	252	450
260	.9672	250	468
270	.9922	246	486
280	1.0168	243	504
290	1.0411	241	522
300	1.0652	237	540
310	1.0889	236	558
320	1.1125	233	576
330	1.1358	230	594
340	1.1588	229	612
350	1.1817	22	630
360	1.204	23	648
370	1.227	22	666
380	1.249	22	684
390	1.271	21	702
400	1.292		720

°K	η/η_0		°R
400	1.292	22	720
410	1.314	22	738
420	1.336	22	756
430	1.358	21	774
440	1.379	21	792
450	1.400	21	810
460	1.421	21	828
470	1.442	20	846
480	1.462	20	864
490	1.482	21	882
500	1.503	20	900
510	1.523	20	918
520	1.543	21	936
530	1.562	20	954
540	1.582	20	972
550	1.602	20	990
560	1.622	20	1008
570	1.642	19	1026
580	1.661	19	1044
590	1.680	19	1062
600	1.699	19	1080
610	1.718	19	1098
620	1.737	19	1116
630	1.756	19	1134
640	1.775	19	1152
650	1.794	18	1170
660	1.812	18	1188
670	1.830	19	1206
680	1.849	17	1224
690	1.866	18	1242
700	1.884	18	1260
710	1.902	19	1278
720	1.921	18	1296
730	1.939	18	1314
740	1.957	17	1332
750	1.974	17	1350
760	1.991	18	1368
770	2.009	18	1386
780	2.027	17	1404
790	2.044	17	1422
800	2.061		1440

°K	η/η_0		°R
800	2.061	17	1440
810	2.078	18	1458
820	2.096	17	1476
830	2.113	17	1494
840	2.130	17	1512
850	2.147	17	1530
860	2.164	16	1548
870	2.180	17	1566
880	2.197	17	1584
890	2.214	16	1602
900	2.230	16	1620
910	2.246	17	1638
920	2.263	17	1656
930	2.280	17	1674
940	2.297	17	1692
950	2.313	16	1710
960	2.329	16	1728
970	2.345	16	1746
980	2.361	16	1764
990	2.377	16	1782
1000	2.393	16	1800
1010	2.409	16	1818
1020	2.425	15	1836
1030	2.440	16	1854
1040	2.456	16	1872
1050	2.472	15	1890
1060	2.487	15	1908
1070	2.502	16	1926
1080	2.518	16	1944
1090	2.534	15	1962
1100	2.549		1980

Table 6-9. THERMAL CONDUCTIVITY OF HYDROGEN AT ATMOSPHERIC PRESSURE

^oK	k/k_0		^oR
10	.044	48	18
20	.092	44	36
30	.136	41	54
40	.177	38	72
50	.215	36	90
60	.251	35	108
70	.286	36	126
80	.322	36	144
90	.358	37	162
100	.395	37	180
110	.432	38	198
120	.470	38	216
130	.508	38	234
140	.546	37	252
150	.583	37	270
160	.620	36	288
170	.656	37	306
180	.693	35	324
190	.728	34	342
200	.762	35	360
210	.797	34	378
220	.831	32	396
230	.863	33	414
240	.896	32	432
250	.928	31	450
260	.959	31	468
270	.990	31	486
280	1.021	30	504
290	1.051	29	522
300	1.080	29	540
310	1.109	29	558
320	1.138	28	576
330	1.166	28	594
340	1.194	28	612
350	1.222		630
350	1.222	27	630
360	1.249	27	648
370	1.276	27	666
380	1.303	27	684
390	1.330	26	702
400	1.356	27	720
410	1.383	26	738
420	1.409	27	756
430	1.436	26	774
440	1.462	26	792
450	1.488	26	810
460	1.514	26	828
470	1.540	26	846
480	1.566	25	864
490	1.591	25	882
500	1.616	26	900
510	1.642	26	918
520	1.668	25	936
530	1.693	25	954
540	1.718	25	972
550	1.743	26	990
560	1.769	26	1008
570	1.795	25	1026
580	1.820	25	1044
590	1.845	26	1062
600	1.871	26	1080
610	1.897	26	1098
620	1.923	26	1116
630	1.949	26	1134
640	1.975	26	1152
650	2.001	26	1170
660	2.027	26	1188
670	2.053	25	1206
680	2.078	25	1224
690	2.103	25	1242
700	2.128		1260

Table 6-10. PRANDTL NUMBER OF HYDROGEN AT ATMOSPHERIC PRESSURE $\eta C_p/k$

°K	(N_{Pr})		$(N_{Pr})^{2/3}$		$(N_{Pr})^{1/2}$		$(N_{Pr})^{1/3}$		°R
60	.713	-2	.798	-1	.844	-1	.893	-1	108
80	.711	1	.797		.843	1	.892	1	144
100	.712	3	.797	3	.844	2	.893	1	180
120	.715	3	.800	2	.846	1	.894	1	216
140	.718	1	.802		.847	1	.895	1	252
160	.719	1	.802	1	.848	1	.896		288
180	.720	-1	.803	-1	.849	-1	.896		324
200	.719	-2	.802	-1	.848	-1	.896	-1	360
220	.717	-2	.801	-1	.847	-1	.895	-1	396
240	.715	-3	.800	-3	.846	-2	.894	-1	432
260	.712	-3	.797	-2	.844	-2	.893	-1	468
280	.709	-3	.795	-2	.842	-2	.892	-2	504
300	.706	-3	.793	-2	.840	-2	.890	-1	540
320	.703	-4	.791	-3	.838	-2	.889	-2	576
340	.699	-3	.788	-2	.836	-2	.887	-1	612
360	.696	-3	.786	-3	.834	-1	.886	-1	648
380	.693	-3	.783	-2	.833	-2	.885	-1	684
400	.690	-3	.781	-2	.831	-2	.884	-2	720
420	.687	-3	.779	-3	.829	-2	.882	-1	756
440	.684	-3	.776	-2	.827	-2	.881	-1	792
460	.681	-3	.774	-2	.825	-1	.880	-2	828
480	.678	-3	.772	-2	.824	-2	.878	-1	864
500	.675	-4	.770	-3	.822	-3	.877	-2	900
520	.671	-2	.767	-2	.819	-1	.875		936
540	.669	-2	.765	-2	.818	-1	.875	-1	972
560	.667	-2	.763	-1	.817	-2	.874	-1	1008
580	.665	-1	.762	-1	.815		.873	-1	1044
600	.664	-1	.761	-1	.815	-1	.872		1080
620	.663		.760		.814		.872		1116
640	.663	-1	.760	-1	.814	-1	.872		1152
660	.662	-1	.759		.813		.872	-1	1188
680	.661		.759		.813		.871		1224
700	.661		.759		.813		.871		1260
720	.661	-1	.759	-1	.813	-1	.871		1296
740	.660		.758		.812		.871		1332
760	.660		.758		.812		.871		1368
780	.660		.758		.812		.871		1404
800	.660		.758		.812		.871		1440

Table 6-11. VAPOR PRESSURE OF e - H_2 (.21% ortho and 99.79 % para at 20.4°K)

Remarks	T	P	P	P	T
	°K	mm Hg	atm	psia	°R
Triple point	13.81_3	52.8	.0695	1.02	24.86_3
Normal boiling point	20.27_8	760.0	1.000	14.696	36.50_0
Critical point	32.9_{94}	9705	12.7_{70}	$187._{67}$	59.3_{89}
Solid	10	1.93	.00254	.0373	18.0
	11	5.62	.00739	.109	19.8
	12	13.9	.0183	.269	21.6
	13	30.2	.0397	.584	23.4
Liquid	14	58.8	.0774	1.137	25.2
	15	100.3	.1320	1.939	27.0
	16	161.1	.2120	3.115	28.8
	17	246.0	.3237	4.757	30.6
	18	360.3	.4741	6.967	32.4
	19	509.5	.6704	9.852	34.2
	20	699.2	.9200	13.520	36.0
	21	935.3	1.2307	18.086	37.8
	22	1223.7	1.6101	23.663	39.6
	23	1570.5	2.0664	30.369	41.4
	24	1981.8	2.6076	38.322	43.2
	25	2463.8	3.2418	47.642	45.0
	26	3022.9	3.9775	58.45	46.8
	27	3665.1	4.8225	70.87	48.6
	28	4396.8	5.785	85.02	50.4
	29	5227.	6.877	101.07	52.2
	30	6162.	8.108	119.16	54.0
	31	7210.	9.486	139.41	55.8
	32	8383.	11.031	162.10	57.6

Table 6-11/a. VAPOR PRESSURE OF LIQUID e-H_2 (.21% ortho and 99.79% para at 20.4°K)

200/T	T	$Log_{10}P$ (atm)**		P	T	360/T
°K⁻¹	°K			atm	°R	°R⁻¹
14.5	13.793	(8.8368-10)'	242	(.0687)	24.828	14.5
14.4	13.889	8.8610-10	242	.0726	25.000	14.4
14.3	13.986	8.8852-10	242	.0768	25.175	14.3
14.2	14.085	8.9094-10	242	.0812	25.352	14.2
14.1	14.184	8.9336-10	243	.0858	25.532	14.1
14.0	14.286	8.9579-10	243	.0908	25.714	14.0
13.9	14.388	8.9822-10	244	.0960	25.899	13.9
13.8	14.493	9.0066-10	244	.1015	26.087	13.8
13.7	14.599	9.0310-10	244	.1074	26.277	13.7
13.6	14.706	9.0554-10	244	.1136	26.471	13.6
13.5	14.815	9.0798-10	245	.1202	26.667	13.5
13.4	14.925	9.1043-10	245	.1272	26.866	13.4
13.3	15.038	9.1288-10	245	.1345	27.068	13.3
13.2	15.152	9.1533-10	246	.1423	27.273	13.2
13.1	15.267	9.1779-10	247	.1506	27.481	13.1
13.0	15.385	9.2026-10	246	.1594	27.692	13.0
12.9	15.504	9.2272-10	247	.1687	27.907	12.9
12.8	15.625	9.2519-10	247	.1786	28.125	12.8
12.7	15.748	9.2766-10	248	.1891	28.346	12.7
12.6	15.873	9.3014-10	248	.2002	28.571	12.6
12.5	16.000	9.3262-10	249	.2119	28.800	12.5
12.4	16.129	9.3511-10	249	.2244	29.032	12.4
12.3	16.260	9.3760-10	250	.2377	29.268	12.3
12.2	16.393	9.4010-10	250	.2518	29.507	12.2
12.1	16.529	9.4260-10	250	.2667	29.572	12.1
12.0	16.667	9.4510-10	251	.2825	30.001	12.0
11.9	16.807	9.4761-10	251	.2993	30.253	11.9
11.8	16.949	9.5012-10	252	.3171	30.508	11.8
11.7	17.094	9.5264-10	252	.3361	30.769	11.7
11.6	17.241	9.5516-10	253	.3561	31.034	11.6
11.5	17.391	9.5769-10	254	.3775	31.304	11.5
11.4	17.544	9.6023-10	254	.4002	31.579	11.4
11.3	17.699	9.6277-10	255	.4243	31.867	11.3
11.2	17.857	9.6532-10	255	.4500	32.143	11.2
11.1	18.018	9.6787-10	256	.4772	32.432	11.1
11.0	18.182	9.70425-10	2564	.5061	32.728	11.0
10.9	18.349	9.72989-10	2571	.5369	33.028	10.9
10.8	18.519	9.75560-10	2578	.5696	33.334	10.8
10.7	18.692	9.78138-10	2585	.6045	33.646	10.7
10.6	18.868	9.80723-10	2591	.6416	33.962	10.6
10.5	19.048	9.83314-10	2598	.6810	34.286	10.5
10.4	19.231	9.85912-10	2606	.7230	34.616	10.4
10.3	19.417	9.88518-10	2613	.7677	34.951	10.3
10.2	19.608	9.91131-10	2621	.8153	35.294	10.2
10.1	19.802	9.93752-10	2628	.8660	35.644	10.1
10.0	20.000	9.96380-10	2637	.9200	36.000	10.0
9.9	20.202	9.99017-10	2646	.9776	36.364	9.9
9.8	20.408	.01663	2654	1.0390	36.734	9.8
9.7	20.619	.04317	2663	1.1045	37.114	9.7
9.6	20.833	.06980	2672	1.1744	37.499	9.6

' Figures in parentheses are extrapolated to permit interpolation to the critical point and triple point.

** Tabulated values in this column are for interpolation with respect to reciprocal temperature.

Table 6-11/a. VAPOR PRESSURE OF LIQUID e-H_2 (.21% ortho and 99.79% para at 20.4°K) - Cont.

200/T	T	$Log_{10}P$(atm)**		P	T	360/T
$°K^{-1}$	°K			atm	°R	$°R^{-1}$
9.5	21.053	.09652	2682	1.2489	37.895	9.5
9.4	21.277	.12334	2692	1.3284	38.299	9.4
9.3	21.505	.15026	2702	1.4134	38.709	9.3
9.2	21.739	.17728	2712	1.5041	39.130	9.2
9.1	21.978	.20440	2723	1.6010	39.560	9.1
9.0	22.222	.23163	2735	1.7046	40.000	9.0
8.9	22.472	.25898	2746	1.8154	40.450	8.9
8.8	22.727	.28644	2758	1.9339	40.909	8.8
8.7	22.989	.31402	2770	2.0607	41.380	8.7
8.6	23.256	.34172	2783	2.1964	41.861	8.6
8.5	23.529	.36955	2797	2.3418	42.352	8.5
8.4	23.810	.39752	2810	2.4976	42.858	8.4
8.3	24.096	.42562	2825	2.6645	43.373	8.3
8.2	24.390	.45387	2839	2.8436	43.902	8.2
8.1	24.691	.48226	2854	3.0357	44.444	8.1
8.0	25.000	.51080	2869	3.2419	45.000	8.0
7.9	25.316	.53949	2886	3.4633	45.569	7.9
7.8	25.641	.56835	2903	3.7013	46.154	7.8
7.7	25.974	.59738	2919	3.9571	46.753	7.7
7.6	26.316	.62657	2936	4.2322	47.369	7.6
7.5	26.667	.65593	2954	4.5282	48.001	7.5
7.4	27.027	.68547	2973	4.8470	48.649	7.4
7.3	27.397	.71520	2993	5.1904	49.315	7.3
7.2	27.778	.74513	3016	5.5607	50.000	7.2
7.1	28.169	.77529	3040	5.961	50.704	7.1
7.0	28.571	.80569	3066	6.393	51.428	7.0
6.9	28.986	.83635	3092	6.860	52.175	6.9
6.8	29.412	.86727	3119	7.367	52.942	6.8
6.7	29.851	.89846	3146	7.915	53.732	6.7
6.6	30.303	.92992	3173	8.510	54.545	6.6
6.5	30.769	.96165	3205	9.155	55.384	6.5
6.4	31.250	.99370	3247	9.856	56.250	6.4
6.3	31.746	1.02617	3303	10.621	57.143	6.3
6.2	32.258	1.05920	3381	11.460	58.064	6.2
6.1	32.787	1.09301	3487	12.388	59.017	6.1
6.0	33.333	(1.12788)'	3629	(13.424)	60.000	6.0
5.9	33.898	(1.16417)		(14.594)	61.016	5.9

' Figures in parentheses are extrapolated to permit interpolation to the critical point and triple point.

**Tabulated values in this column are for interpolation with respect to reciprocal temperature.

Table 6-11/b. CONSTANTS FOR $LOG_{10}P$ (SOLID) = A - B/T + CT

Units of P	A	Units of T	B	C
mm Hg	4.62438	°K	47.0172	0.03635
atm	1.74357	°R	84.6310	0.02019
psia	2.91076			

Table 6-12. IDEAL-GAS THERMODYNAMIC FUNCTIONS FOR MOLECULAR HYDROGEN**

°K	$\frac{C_p^\circ}{R}$		$\frac{(H^\circ - E_0^\circ)}{RT_0}$ *		$\frac{S^\circ}{R}$		$\frac{-(F^\circ - E_0^\circ)}{RT}$		°R
10	2.500		.55943	9153	6.468	1732	− 8.813	8122	18
20	2.500		.65096	9152	8.200	1014	− .691	3144	36
30	2.500	1	.74248	9153	9.214	719	2.453	1785	54
40	2.501	4	.83401	9160	9.933	558	4.238	1196	72
50	2.505	14	.92561	919	10.491	458	5.434	883	90
60	2.519	28	1.0175	927	10.949	390	6.317	690	108
70	2.547	44	1.1102	940	11.339	343	7.007	563	126
80	2.591	57	1.2042	958	11.682	308	7.570	474	144
90	2.648	66	1.3000	981	11.990	282	8.044	409	162
100	2.714	71	1.3981	1007	12.272	263	8.453	360	180
110	2.785	72	1.4988	1033	12.535	245	8.813	320	198
120	2.857	70	1.6021	1058	12.780	231	9.133	289	216
130	2.927	66	1.7079	1084	13.011	220	9.422	265	234
140	2.993	60	1.8163	1107	13.231	208	9.687	243	252
150	3.053	55	1.9270	1128	13.439	199	9.930	226	270
160	3.108	50	2.0398	1147	13.638	190	10.156	210	288
170	3.158	46	2.1545	1165	13.828	182	10.366	198	306
180	3.204	40	2.2710	1180	14.010	175	10.564	186	324
190	3.244	36	2.3890	1195	14.185	167	10.750	176	342
200	3.280	32	2.5085	1206	14.352	161	10.926	167	360
210	3.312	28	2.6291	1218	14.513	154	11.093	158	378
220	3.340	26	2.7509	1228	14.667	149	11.251	152	396
230	3.366	21	2.8737	1236	14.816	144	11.403	146	414
240	3.387	20	2.9973	1244	14.960	139	11.549	139	432
250	3.407	17	3.1217	1250	15.099	133	11.688	133	450
260	3.424	14	3.2467	1256	15.232	130	11.821	129	468
270	3.438	12	3.3723	1260	15.362	126	11.950	125	486
280	3.450	11	3.4983	1265	15.488	121	12.075	120	504
290	3.461	8	3.6248	1269	15.609	117	12.195	115	522
300	3.469	8	3.7517	1271	15.726	114	12.310	112	540
310	3.477	6	3.8788	1275	15.840	111	12.422	109	558
320	3.483	6	4.0063	1276	15.951	107	12.531	105	576
330	3.489	5	4.1339	1278	16.058	104	12.636	102	594
340	3.494	4	4.2617	1280	16.162	102	12.738	100	612
350	3.498	3	4.3897	1281	16.264	98	12.838	96	630
360	3.501	3	4.5178	1282	16.362	96	12.934	94	648
370	3.504	3	4.6460	1283	16.458	94	13.028	92	666
380	3.507	2	4.7743	1284	16.552	91	13.120	89	684
390	3.509	1	4.9027	1285	16.643	89	13.209	87	702
400	3.510	2	5.0312	1285	16.732	87	13.296	85	720
410	3.512	1	5.1597	1286	16.819	84	13.381	83	738
420	3.513	1	5.2883	1286	16.903	83	13.464	81	756
430	3.514	1	5.4169	1286	16.986	80	13.545	78	774
440	3.515	1	5.5455	1287	17.066	79	13.623	78	792
450	3.516		5.6742	1287	17.145	78	13.701	76	810
460	3.516	1	5.8029	1287	17.223	75	13.777	74	828
470	3.517	1	5.9316	1288	17.298	74	13.851	72	846
480	3.518	1	6.0604	1288	17.372	73	13.923	72	864
490	3.519		6.1892	1288	17.445	71	13.995	69	882
500	3.519	1	6.3180	1288	17.516	70	14.064	69	900
510	3.520	1	6.4468	1289	17.586	69	14.133	68	918
520	3.521	1	6.5757	1289	17.655	66	14.201	64	936
530	3.522		6.7046	1289	17.721	66	14.265	65	954
540	3.522	1	6.8335	1290	17.787	65	14.330	64	972
550	3.523		6.9625		17.852		14.394		990

*The enthalpy function is divided here by a constant RT_0 where T_0 = 273.16°K (491.688°R).

**These tables are calculated for normal hydrogen (75% ortho - 25% para).

Table 6-12. IDEAL-GAS THERMODYNAMIC FUNCTIONS FOR MOLECULAR HYDROGEN – Cont.**

°K	$\frac{C_p^\circ}{R}$		$\frac{(H^\circ - E_0^\circ)}{RT_0}$ *		$\frac{S^\circ}{R}$		$\frac{-(F^\circ - E_0^\circ)}{RT}$		°R
550	3.523	1	6.9625	1290	17.852	63	14.394	62	990
560	3.524	1	7.0915	1290	17.915	63	14.456	62	1008
570	3.525		7.2205	1290	17.978	60	14.518	59	1026
580	3.525	1	7.3495	1291	18.038	61	14.577	60	1044
590	3.526	1	7.4786	1291	18.099	59	14.637	57	1062
600	3.527	1	7.6077	1291	18.158	59	14.694	58	1080
610	3.528	1	7.7368	1292	18.217	57	14.752	56	1098
620	3.529	2	7.8660	1292	18.274	56	14.808	55	1116
630	3.531	1	7.9952	1292	18.330	56	14.863	55	1134
640	3.532	1	8.1244	1293	18.386	55	14.918	54	1152
650	3.533	2	8.2537	1294	18.441	53	14.972	52	1170
660	3.535	1	8.3831	1294	18.494	54	15.024	53	1188
670	3.536	2	8.5125	1295	18.548	52	15.077	51	1206
680	3.538	1	8.6420	1296	18.600	52	15.128	51	1224
690	3.539	2	8.7716	1296	18.652	51	15.179	51	1242
700	3.541	2	8.9012	1297	18.703	50	15.230	49	1260
710	3.543	2	9.0309	1297	18.753	49	15.279	48	1278
720	3.545	2	9.1606	1298	18.802	49	15.327	48	1296
730	3.547	2	9.2904	1299	18.851	49	15.375	48	1314
740	3.549	2	9.4203	1300	18.900	47	15.423	46	1332
750	3.551	2	9.5503	1300	18.947	47	15.469	46	1350
760	3.553	3	9.6803	1301	18.994	47	15.515	46	1368
770	3.556	2	9.8104	1303	19.041	46	15.561	45	1386
780	3.558	3	9.9407	130	19.087	45	15.606	44	1404
790	3.561	2	10.071	130	19.132	45	15.650	44	1422
800	3.563	15	10.201	654	19.177	216	15.694	211	1440
850	3.578	16	10.855	656	19.393	205	15.905	199	1530
900	3.594	19	11.511	660	19.598	195	16.104	189	1620
950	3.613	20	12.171	663	19.793	185	16.293	179	1710
1000	3.633	21	12.834	667	19.978	178	16.472	172	1800
1050	3.654	24	13.501	671	20.156	171	16.644	164	1890
1100	3.678	24	14.172	675	20.327	164	16.808	156	1980
1150	3.702	25	14.847	680	20.491	158	16.964	151	2070
1200	3.727	26	15.527	684	20.649	152	17.115	143	2160
1250	3.753	27	16.211	690	20.801	148	17.258	140	2250
1300	3.780	26	16.901	694	20.949	144	17.398	135	2340
1350	3.806	27	17.595	699	21.093	139	17.533	130	2430
1400	3.833	26	18.294	704	21.232	134	17.663	124	2520
1450	3.859	26	18.998	709	21.366	132	17.787	122	2610
1500	3.885	26	19.707	714	21.498	128	17.909	118	2700
1550	3.911	25	20.421	718	21.626	124	18.027	114	2790
1600	3.936	24	21.139	723	21.750	121	18.141	111	2880
1650	3.960	25	21.862	727	21.871	119	18.252	108	2970
1700	3.985	24	22.589	731	21.990	116	18.360	106	3060
1750	4.009	24	23.320	736	22.106	113	18.466	102	3150
1800	4.033	24	24.056	741	22.219	111	18.568	101	3240
1850	4.057	23	24.797	744	22.330	108	18.669	97	3330
1900	4.080	22	25.541	749	22.438	107	18.766	96	3420
1950	4.102	22	26.290	753	22.545	104	18.862	93	3510
2000	4.124	21	27.043	757	22.649	102	18.955	92	3600
2050	4.145	20	27.800	760	22.751	100	19.047	89	3690
2100	4.165	20	28.560	765	22.851	98	19.136	87	3780
2150	4.185	19	29.325	767	22.949	97	19.223	87	3870
2200	4.204	19	30.092	772	23.046	94	19.310	83	3960
2250	4.223	18	30.864	774	23.140	93	19.393	83	4050
2300	4.241		31.638		23.233		19.476		4140

* The enthalpy function is divided here by a constant RT_0 where T_0 = 273.16°K (491.699°R).

**These tables are calculated for normal hydrogen (75% ortho - 25% para).

°K	$\frac{C_p^\circ}{R}$		$\frac{(H^\circ - E_0^\circ)}{RT_0}$ *		$\frac{S^\circ}{R}$		$\frac{-(F^\circ - E_0^\circ)}{RT}$		°R
2300	4.241	17	31.638	778	23.233	92	19.476	81	4140
2350	4.258	18	32.416	781	23.325	90	19.557	80	4230
2400	4.276	17	33.197	785	23.415	88	19.637	77	4320
2450	4.293	17	33.982	787	23.503	87	19.714	77	4410
2500	4.310	16	34.769	790	23.590	86	19.791	76	4500
2550	4.326	16	35.559	794	23.676	84	19.867	74	4590
2600	4.342	16	36.353	796	23.760	83	19.941	73	4680
2650	4.358	15	37.149	799	23.843	81	20.014	71	4770
2700	4.373	14	37.948	802	23.924	81	20.085	71	4860
2750	4.387	15	38.750	804	24.005	79	20.156	69	4950
2800	4.402	14	39.554	807	24.084	78	20.225	69	5040
2850	4.416	14	40.361	810	24.162	77	20.294	67	5130
2900	4.430	15	41.171	812	24.239	76	20.361	67	5220
2950	4.445	13	41.983	815	24.315	74	20.428	64	5310
3000	4.458	14	42.798	817	24.389	74	20.492	65	5400
3050	4.472	14	43.615	821	24.463	73	20.557	63	5490
3100	4.486	13	44.436	821	24.536	72	20.620	63	5580
3150	4.499	14	45.257	826	24.608	71	20.683	62	5670
3200	4.513	14	46.083	827	24.679	70	20.745	61	5760
3250	4.527	13	46.910	829	24.749	69	20.806	60	5850
3300	4.540	13	47.739	833	24.818	69	20.866	60	5940
3350	4.553	13	48.572	834	24.887	67	20.926	59	6030
3400	4.566	12	49.406	837	24.954	67	20.985	58	6120
3450	4.578	13	50.243	840	25.021	66	21.043	57	6210
3500	4.591	12	51.083	840	25.087	65	21.100	57	6300
3550	4.603	11	51.923	843	25.152	64	21.157	55	6390
3600	4.614	12	52.766	846	25.216	64	21.212	56	6480
3650	4.626	11	53.612	847	25.280	63	21.268	54	6570
3700	4.637	11	54.459	850	25.343	62	21.322	54	6660
3750	4.648	10	55.309	853	25.405	62	21.376	54	6750
3800	4.658	11	56.162	855	25.467	61	21.430	53	6840
3850	4.669	11	57.017	854	25.528	61	21.483	53	6930
3900	4.680	10	57.871	859	25.589	59	21.536	51	7020
3950	4.690	11	58.730	858	25.648	59	21.587	51	7110
4000	4.701	11	59.588	861	25.707	59	21.638	51	7200
4050	4.712	11	60.449	864	25.766	58	21.689	50	7290
4100	4.723	10	61.313	866	25.824	57	21.739	49	7380
4150	4.733	11	62.179	867	25.881	56	21.788	49	7470
4200	4.744	11	63.046	870	25.937	57	21.837	49	7560
4250	4.755	11	63.916	871	25.994	55	21.886	47	7650
4300	4.766	10	64.787	874	26.049	56	21.933	49	7740
4350	4.776	10	65.661	875	26.105	54	21.982	46	7830
4400	4.786	11	66.536	877	26.159	55	22.028	48	7920
4450	4.797	10	67.413	878	26.214	53	22.076	46	8010
4500	4.807	10	68.291	881	26.267	53	22.122	45	8100
4550	4.817	11	69.172	882	26.320	53	22.167	46	8190
4600	4.828	10	70.054	885	26.373	52	22.213	45	8280
4650	4.838	10	70.939	886	26.425	52	22.258	45	8370
4700	4.848	10	71.825	888	26.477	51	22.303	43	8460
4750	4.858	9	72.713	891	26.528	51	22.346	44	8550
4800	4.867	10	73.604	892	26.579	50	22.390	43	8640
4850	4.877	10	74.496	894	26.629	51	22.433	44	8730
4900	4.887	9	75.390	895	26.680	49	22.477	42	8820
4950	4.896	10	76.285	897	26.729	50	22.519	43	8910
5000	4.906		77.182		26.779		22.562		9000

*The enthalpy function is divided here by a constant RT_0 where T_0 = 273.16°K (491.688°R).

**These tables are calculated for normal hydrogen (75% ortho - 25% para).

Table 6-12/a. IDEAL-GAS THERMODYNAMIC FUNCTIONS FOR ATOMIC HYDROGEN **

°K	$\frac{C_p^\circ}{R}$	$\frac{(H^\circ - E_0^\circ)}{RT_0}$ *		$\frac{S^\circ}{R}$		$\frac{-(F^\circ - E_0^\circ)}{RT}$		°R
10	2.5000	.0915	915	5.2972	17328	2.7972	17328	18
20		.1830	916	7.0300	10137	4.5300	10137	36
30		.2746	915	8.0437	7192	5.5437	7192	54
40		.3661	915	8.7629	5579	6.2629	5579	72
50		.4576	915	9.3208	4558	6.8208	4558	90
60		.5491	916	9.7766	3853	7.2766	3853	108
70		.6407	915	10.1619	3339	7.6619	3339	126
80		.7322	915	10.4958	2944	7.9958	2944	144
90		.8237	915	10.7902	2634	8.2902	2634	162
100		.9152	915	11.0536	2383	8.5536	2383	180
110		1.0067	916	11.2919	2175	8.7919	2175	198
120		1.0983	915	11.5094	2001	9.0094	2001	216
130		1.1898	915	11.7095	1853	9.2095	1853	234
140		1.2813	915	11.8948	1725	9.3948	1725	252
150		1.3728	915	12.0673	1613	9.5673	1613	270
160		1.4643	916	12.2286	1516	9.7286	1516	288
170		1.5559	915	12.3802	1429	9.8802	1429	306
180		1.6474	915	12.5231	1352	10.0231	1352	324
190		1.7389	915	12.6583	1282	10.1583	1282	342
200		1.8304	916	12.7865	1220	10.2865	1220	360
210		1.9220	915	12.9085	1163	10.4085	1163	378
220		2.0135	915	13.0248	1111	10.5248	1111	396
230		2.1050	915	13.1359	1064	10.6359	1064	414
240		2.1965	915	13.2423	1020	10.7423	1020	432
250		2.2880	916	13.3443	981	10.8443	981	450
260		2.3796	915	13.4424	944	10.9424	944	468
270		2.4711	915	13.5368	909	11.0368	909	486
280		2.5626	915	13.6277	877	11.1277	877	504
290		2.6541	915	13.7154	848	11.2154	848	522
300		2.7456	916	13.8002	819	11.3002	819	540
310		2.8372	915	13.8821	794	11.3821	794	558
320		2.9287	915	13.9615	769	11.4615	769	576
330		3.0202	915	14.0384	747	11.5384	747	594
340		3.1117	916	14.1131	724	11.6131	724	612
350		3.2033	915	14.1855	705	11.6855	705	630
360		3.2948	915	14.2560	685	11.7560	685	648
370		3.3863	915	14.3245	666	11.8245	666	666
380		3.4778	915	14.3911	650	11.8911	650	684
390		3.5693	916	14.4561	633	11.9561	633	702
400		3.6609	915	14.5194	617	12.0194	617	720
410		3.7524	915	14.5811	602	12.0811	602	738
420		3.8439	915	14.6413	589	12.1413	589	756
430		3.9354	915	14.7002	574	12.2002	574	774
440		4.0269	916	14.7576	562	12.2576	562	792
450		4.1185	915	14.8138	550	12.3138	550	810
460		4.2100	915	14.8688	537	12.3688	537	828
470		4.3015	915	14.9225	527	12.4225	527	846
480		4.3930	916	14.9752	515	12.4752	515	864
490		4.4846	915	15.0267	505	12.5267	505	882
500		4.5761	915	15.0772	495	12.5772	495	900
510		4.6676	915	15.1267	486	12.6267	486	918
520		4.7591	915	15.1753	476	12.6753	476	936
530		4.8506	916	15.2229	467	12.7229	467	954
540		4.9422	915	15.2696	459	12.7696	459	972
550	2.5000	5.0337		15.3155		12.8155		990

*The enthalpy function is divided here by a constant RT_0 where T_0 = 273.16°K (491.688°R).

**These tables are calculated for normal hydrogen (75% ortho - 25% para).

Table 6-12/a. IDEAL-GAS THERMODYNAMIC FUNCTIONS FOR ATOMIC HYDROGEN - Cont.**

°K	$\frac{C_p^\circ}{R}$	$\frac{(H^\circ - E_0^\circ)^*}{RT_0}$		$\frac{S^\circ}{R}$		$\frac{-(F^\circ - E_0^\circ)}{RT}$		°R
550	2.5000	5.0337	915	15.3155	450	12.8155	450	990
560		5.1252	915	15.3605	443	12.8605	443	1008
570		5.2167	915	15.4048	435	12.9048	435	1026
580		5.3082	916	15.4483	427	12.9483	427	1044
590		5.3998	915	15.4910	420	12.9910	420	1062
600		5.4913	915	15.5330	413	13.0330	413	1080
610		5.5828	915	15.5743	407	13.0743	407	1098
620		5.6743	916	15.6150	400	13.1150	400	1116
630		5.7659	915	15.6550	394	13.1550	394	1134
640		5.8574	915	15.6944	387	13.1944	387	1152
650		5.9489	915	15.7331	382	13.2331	382	1170
660		6.0404	915	15.7713	376	13.2713	376	1188
670		6.1319	916	15.8089	370	13.3089	370	1206
680		6.2235	915	15.8459	365	13.3459	365	1224
690		6.3150	915	15.8824	360	13.3824	360	1242
700		6.4065	915	15.9184	355	13.4184	355	1260
710		6.4980	915	15.9539	349	13.4539	349	1278
720		6.5895	916	15.9888	345	13.4888	345	1296
730		6.6811	915	16.0233	340	13.5233	340	1314
740		6.7726	915	16.0573	336	13.5573	336	1332
750		6.8641	915	16.0909	331	13.5909	331	1350
760		6.9556	916	16.1240	327	13.6240	327	1368
770		7.0472	915	16.1567	322	13.6567	322	1386
780		7.1387	915	16.1889	319	13.6889	319	1404
790		7.2302	915	16.2208	314	13.7208	314	1422
800		7.3217	4576	16.2522	1516	13.7522	1516	1440
850		7.7793	4576	16.4038	1429	13.9038	1429	1530
900		8.2369	4576	16.5467	1352	14.0467	1352	1620
950		8.6945	4576	16.6819	1282	14.1819	1282	1710
1000		9.1521	4577	16.8101	1220	14.3101	1220	1800
1050		9.6098	4576	16.9321	1163	14.4321	1163	1890
1100		10.0674	4576	17.0484	1111	14.5484	1111	1980
1150		10.5250	4576	17.1595	1064	14.6595	1064	2070
1200		10.9826	4576	17.2659	1020	14.7659	1020	2160
1250		11.4402	4576	17.3679	981	14.8679	981	2250
1300		11.8978	4576	17.4660	943	14.9660	943	2340
1350		12.3554	4576	17.5603	910	15.0603	910	2430
1400		12.8130	4576	17.6513	877	15.1513	877	2520
1450		13.2706	4576	17.7390	847	15.2390	847	2610
1500		13.7282	4576	17.8237	820	15.3237	820	2700
1550		14.1858	4576	17.9057	794	15.4057	794	2790
1600		14.6434	4576	17.9851	769	15.4851	769	2880
1650		15.1010	4576	18.0620	747	15.5620	747	2970
1700		15.5586	4577	18.1367	724	15.6367	724	3060
1750		16.0163	4576	18.2091	705	15.7091	705	3150
1800		16.4739	4576	18.2796	684	15.7796	684	3240
1850		16.9315	4576	18.3480	667	15.8480	667	3330
1900		17.3891	4576	18.4147	650	15.9147	650	3420
1950		17.8467	4576	18.4797	633	15.9797	633	3510
2000		18.3043	4576	18.5430	617	16.0430	617	3600
2050		18.7619	4576	18.6047	602	16.1047	602	3690
2100		19.2195	4576	18.6649	589	16.1649	589	3780
2150		19.6771	4576	18.7238	574	16.2238	574	3870
2200		20.1347	4576	18.7812	562	16.2812	562	3960
2250		20.5923	4576	18.8374	550	16.3374	550	4050
2300	2.5000	21.0499		18.8924		16.3924		4140

*The enthalpy function is divided here by a constant RT_0 where T_0 = 273.16°K (491.688°R).

**These tables are calculated for normal hydrogen (75% ortho - 25% para).

Table 6-12/a. IDEAL-GAS THERMODYNAMIC FUNCTIONS FOR ATOMIC HYDROGEN - Cont.**

°K	$\frac{C_p^\circ}{R}$	$\frac{(H^\circ - E_0^\circ)^*}{RT_0}$		$\frac{S^\circ}{R}$		$\frac{-(F^\circ - E_0^\circ)}{RT}$		°R
2300	2.5000	21.0499	4576	18.8924	537	16.3924	537	4140
2350		21.5075	4576	18.9461	527	16.4461	527	4230
2400		21.9651	4577	18.9988	515	16.4988	515	4320
2450		22.4228	4576	19.0503	505	16.5503	505	4410
2500		22.8804	4576	19.1008	495	16.6008	495	4500
2550		23.3380	4576	19.1503	486	16.6503	486	4590
2600		23.7956	4576	19.1989	476	16.6989	476	4680
2650		24.2532	4576	19.2465	467	16.7465	467	4770
2700		24.7108	4576	19.2932	459	16.7932	459	4860
2750		25.1684	4576	19.3391	450	16.8391	450	4950
2800		25.6260	4576	19.3841	443	16.8841	443	5040
2850		26.0836	4576	19.4284	435	16.9284	435	5130
2900		26.5412	4576	19.4719	427	16.9719	427	5220
2950		26.9988	4576	19.5146	420	17.0146	420	5310
3000		27.4564	4576	19.5566	413	17.0566	413	5400
3050		27.9140	4577	19.5979	407	17.0979	407	5490
3100		28.3717	4576	19.6386	400	17.1386	400	5580
3150		28.8293	4576	19.6786	394	17.1786	394	5670
3200		29.2869	4576	19.7180	387	17.2180	387	5760
3250		29.7445	4576	19.7567	382	17.2567	382	5850
3300		30.2021	4576	19.7949	376	17.2949	376	5940
3350		30.6597	4576	19.8325	370	17.3325	370	6030
3400		31.1173	4576	19.8695	365	17.3695	365	6120
3450		31.5749	4576	19.9060	360	17.4060	360	6210
3500		32.0325	4576	19.9420	355	17.4420	355	6300
3550		32.4901	4576	19.9775	349	17.4775	349	6390
3600		32.9477	4576	20.0124	345	17.5124	345	6480
3650		33.4053	4576	20.0469	340	17.5469	340	6570
3700		33.8629	4576	20.0809	336	17.5809	336	6660
3750		34.3205	4577	20.1145	331	17.6145	331	6750
3800		34.7782	4576	20.1476	327	17.6476	327	6840
3850		35.2358	4576	20.1803	322	17.6803	322	6930
3900		35.6934	4576	20.2125	319	17.7125	319	7020
3950		36.1510	4576	20.2444	314	17.7444	314	7110
4000		36.6086	4576	20.2758	311	17.7758	311	7200
4050		37.0662	4576	20.3069	307	17.8069	307	7290
4100		37.5238	4576	20.3376	303	17.8376	303	7380
4150		37.9814	4576	20.3679	299	17.8679	299	7470
4200		38.4390	4576	20.3978	296	17.8978	296	7560
4250		38.8966	4576	20.4274	292	17.9274	292	7650
4300		39.3542	4576	20.4566	289	17.9566	289	7740
4350		39.8118	4576	20.4855	286	17.9855	286	7830
4400		40.2694	4576	20.5141	282	18.0141	282	7920
4450		40.7270	4577	20.5423	280	18.0423	280	8010
4500		41.1847	4576	20.5703	276	18.0703	276	8100
4550		41.6423	4576	20.5979	273	18.0979	273	8190
4600		42.0999	4576	20.6252	271	18.1252	271	8280
4650		42.5575	4576	20.6523	267	18.1523	267	8370
4700		43.0151	4576	20.6790	264	18.1790	264	8460
4750		43.4727	4576	20.7054	262	18.2054	262	8550
4800		43.9303	4576	20.7316	259	18.2316	259	8640
4850		44.3879	4576	20.7575	257	18.2575	257	8730
4900		44.8455	4576	20.7832	254	18.2832	254	8820
4950		45.3031	4576	20.8086	251	18.3086	251	8910
5000		45.7607		20.8337		18.3337		9000

*The enthalpy function is divided here by a constant RT_0 where T_0 = 273.16°K (491.688°R).

**These tables are calculated for normal hydrogen (75% ortho - 25% para).

Table 6-13. COEFFICIENTS (AND TEMPERATURE DERIVATIVES) FOR THE EQUATION OF STATE FOR HYDROGEN*

$$T^{3/2}\frac{V}{V_0}\left(1-\frac{PV}{RT}\right) = A + C\rho$$

T	A	C	dA/dT	dC/dT	T	A	C	dA/dT	dC/dT
°K	$°K^{3/2}$	$°K^{3/2}$	$°K^{1/2}$	$°K^{1/2}$	°K	$°K^{3/2}$	$°K^{3/2}$	$°K^{1/2}$	$°K^{1/2}$
14	0.5754	$-5,621 \times 10^{-7}$	0.00388	-75×10^{-8}	36	.5805	$-5,943 \times 10^{-7}$	-.00280	-282×10^{-8}
16	.5827	-5,636	.00330	-82	38	.5746	-6,003	-.00317	-320
18	.5887	-5,653	.00264	-90	40	.5679	-6,071	-.00356	-358
20	.5933	-5,672	.00192	-100	42	.5604	-6,146	-.00397	-396
22	.5965	-5,693	.00116	-112	44	.5521	-6,229	-.00438	-436
24	.5981	-5,716	.00040	-127	46	.5429	-6,320	-.00476	-478
26	.5981	-5,743	-.00032	-145	48	.5330	-6,420	-.00509	-522
28	.5966	-5,774	-.00097	-165	50	.5225	-6,529	-.00540	-565
30	.5940	-5,809	-.00154	-187	52	.5114	-6,646	-.00572	-603
32	.5904	-5,848	-.00202	-213	54	.4996	-6,770	-.00608	-636
34	.5858	-5,892	-.00243	-245	56	.4871	-6,900	-.00650	-664

*A discussion of this equation, which is applicable at Amagat densities, ρ, less than 200, is in reference 1.