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COLLISIONAL EXCITATION OF INTERSTELLAR MOLECULES: LINEAR MOLECULES CO, CS, OCS, AND HC_3N*

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ABSTRACT

Rates for excitation of CO, CS, OCS, and HC_3N by collisions with He atoms and H_2 molecules are presented. These have been obtained from extensive theoretical calculations using methods of known reliability. In general, rates necessary for modeling interstellar molecular clouds with kinetic temperatures to 100 K have been included. Methods for fitting these rates in more compact form are discussed.

Subject headings: interstellar: molecules — molecular processes — transition probabilities

I. INTRODUCTION

Analysis of radiofrequency and microwave spectra of interstellar molecules requires an understanding of the line formation mechanism, i.e., the means of exciting and de-exciting the observed molecular levels. For conditions in typical interstellar clouds, two molecular processes are important: radiative transitions among levels, and collisions with the dominant neutral species, H_2 and He. The radiative rates are generally well known. For the rotational transitions of interest they are simply related to the permanent electric dipole moment of the molecule; they are generally known experimentally. Collisional rates, on the other hand, have been more difficult to obtain. The line formation problem requires knowledge of rates between specific quantum levels, and current experimental techniques for the most part measure only averages over many transitions. Furthermore, collisional rates depend on the kinetic temperature, and it is often difficult to obtain even averaged rates at the low temperatures of interstellar clouds.

In principle it is possible to obtain the required rates *ab initio*, i.e., by solving the appropriate quantum-mechanical equations. Fortunately, the extreme physical conditions in interstellar space, which make experimental measurements difficult, facilitate the theoretical approach by limiting the number of accessible scattering channels. We have discussed the theoretical techniques in some detail previously (Green and Thaddeus 1976) where they were applied to excitation of CO. Similar calculations have been presented for the collisional excitation of other linear molecules: HCN (Green and Thaddeus 1974), N_2H^+ (Green 1975), HCl (Green and Monchick 1975), and HD (Green 1974). The theoretical techniques become computationally expensive when many rotational levels (more than about 6–8) are energetically accessible, and this prevented calculations for heavier molecules with smaller rotational constants. To overcome this problem, several approximate scattering methods have been proposed, and these have now been tested against the accurate quantum results available for the systems listed above. The coupled states method (McGuire and Kouri 1974) appears to be acceptably accurate and is computationally feasible when up to about 20 rotational levels are of interest. When more levels than this are accessible, one expects that classical mechanics will provide an accurate description, and this has been demonstrated to be true (Chapman and Green 1977).

Using these approximate techniques, we have computed collisional excitation rates for several additional systems of current astrophysical interest: CS, OCS, and HC_3N. Also, earlier calculations for CO have been extended to include higher rotational levels.

The theoretical treatment is significantly simplified for collisions with spherical ground-state atoms such as He, and most of our calculations to date have considered only excitation by collisions with He. In low-temperature interstellar clouds, H_2 molecules are expected to be in their lowest, $J = 0$ rotational level (Dalgarno, Oppenheimer, and Black 1973), and collisional excitation to higher levels is not energetically possible. In that case, H_2 acts like a spherical particle. In fact, we have argued that H_2 ($J = 0$) is quite similar to He except for the smaller reduced mass (Green and Thaddeus 1976; Green *et al.* 1978). Thus rates for excitation by H_2 are expected to be somewhat larger (about 50%) than corresponding rates for He. The present calculations for CS and OCS have been performed for collisions with H_2 ($J = 0$); i.e., the reduced mass and the long-range part of the interaction potential were computed for H_2. The CO and HC_3N results here are for collisions with He atoms.

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The next section describes details of the calculation for each molecule; numerical results are collected in the Appendix. When many levels are accessible the number of state-to-state rate constants becomes rather large, and tabulation and manipulation of this body of data can be a problem. Methods for "fitting" this data are discussed in § III.

II. DETAILS OF CALCULATIONS

a) CO–He

The present calculations extend the earlier studies of Green and Thaddeus (1976). These authors considered several intermolecular potentials, and we adopt here their "modified *ab initio* (MAI)" potential, which appeared to be the most accurate. They also studied convergence of cross sections with basis set size, and presented close coupling (CC) rates for rotor levels to $J = 6$. The coupled states (CS) approximation has been shown to be quite reliable for this system when compared with the CC results, especially at higher collision energies (Green 1976). Using the CS approximation, additional calculations have been done to obtain converged cross sections for rotational levels to $J = 9$ for a range of energies. These cross sections plus the earlier CC values have been averaged over Boltzmann distributions of collision energies to obtain rate constants which are tabulated in the Appendix.

b) CS–H_2 ($J = 0$)

The interaction potential for this system was adapted from a Gordon and Kim (1972; see also Green, Garrison, and Lester 1975) electron gas model for CS–He, treating the CS molecule as a rigid rotor with bond length $r_e = 2.8996$ Bohr radii. The interaction was computed for intermolecular distances $R = 3.0(0.5)10.0$ Bohr radii and for 11 orientations. The angle dependence was fitted to eight terms in a Legendre polynomial expansion by minimizing the root-mean-square average deviation. For distances greater than about 8 Bohr radii the lowest four Legendre terms were modified to join smoothly with the asymptotic electrostatic interaction (cf. Green and Thaddeus 1976), using molecular parameters for CS and H_2 listed in Table 1. The final potential is given in Table 2.

TABLE 1

MOLECULAR PARAMETERS USED FOR LONG-RANGE INTERACTION*

	H_2	CS	OCS
Dipole, debye	...	1.96[a]	0.712[b]
Quadrupole, buckingham†	...	2.0[c]	−0.88[d]
Polarizability, Å³	0.79[e]	6.0[c,e]	5.7[c,e]
Polarizability, perpendicular, Å³	...	1.6[c,e]	3.7[c,e]
Polarizability, parallel, Å³	...	2.8[c,e]	9.6[c,e]
Ionization potential, eV	15.6[e]	12.4[c]	11.0[c]

* Cf. Green and Thaddeus 1976.

† 1 buckingham = 10^{-26} esu cm².

REFERENCES.—(*a*) Mockler and Bird 1955; (*b*) Weiss 1963; (*c*) Estimated from Hartree-Fock calculations and/or comparison with data for similar molecules; (*d*) Flygare *et al.* 1969; (*e*) Hirschfelder *et al.* 1954.

The collisional reduced mass was taken as 1.928 amu. Rotational energy levels were computed from the usual spectroscopic constants, $B_0 = 0.81709$ cm^{-1} and $D_0 = 1 \times 10^{-6}$ cm^{-1}. To test convergence with basis set size and to compare the coupled states approximation with the accurate close coupling method, scattering calculations at a few energies were done with basis sets of varying size; selected results are presented in Table 3. Final cross sections were obtained from a CC/B7 calculation for energies to 50 cm^{-1}; from a CS/B16 calculation for energies to 150 cm^{-1}; and from a CS/B20 calculation for higher energies. (The notation "B*n*" indicates a basis set containing rotational levels from $J = 0$ through $J = n$.) These cross sections were integrated numerically over Boltzmann distributions of collision energies to obtain rate constants at temperatures from 10 K to 100 K; these are tabulated in the Appendix for rotational levels to $J = 12$.

TABLE 2

INTERACTION POTENTIAL FOR CS–H_2 ($J = 0$)

R	v_0	v_1	v_2	v_3	v_4	v_5	v_6	v_7
3.0	+45614.25	+36009.43	+85065.43	+69094.50	+62754.82	+39924.36	+31046.76	22568.96
3.5	+19715.35	+16414.78	+36051.48	+26572.04	+22566.00	+14108.26	+9295.72	5248.97
4.0	+8706.19	+8267.98	+16859.21	+12218.34	+9906.08	+6423.56	+3463.31	1456.40
4.5	+3619.11	+4137.96	+7781.94	+5851.52	+4718.30	+2941.33	+1572.41	752.37
5.0	+1377.03	+1931.18	+3363.18	+2698.20	+2136.52	+1300.40	+741.50	350.44
5.5	+436.19	+826.73	+1348.46	+1131.83	+921.23	+615.30	+309.23	95.40
6.0	+92.88	+317.21	+479.54	+435.34	+357.84	+259.24	+121.65	26.98
6.5	−16.12	+94.63	+136.78	+144.79	+129.29	+91.69	+52.71	20.11
7.0	−35.71	+16.39	+19.64	+37.97	+41.50	+29.74	+25.36	16.38
7.5	−29.63	−5.62	−12.00	+0.72	+8.40	+8.10	+8.53	5.71
8.0	−19.42	−8.59	−14.90	−7.66	−1.50	+1.05	+1.71	0.51
8.5	−11.37	−6.83	−11.14	−7.05	−3.18	−1.40	+0.21	0.18
9.0	−6.27	−4.32	−6.95	−4.95	−2.60	−1.54	−0.16	0.05
9.5	−3.32	−2.35	−3.85	−3.01	−1.54	−1.01	−0.18	0.00
10.0	−1.75	−1.25	−1.96	−1.66	−0.73	−0.59	−0.15	0.00

* Distances in Bohr radii, energies in cm^{-1}; the angle $\theta = 0$ corresponds to linear SC–H_2.

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TABLE 3

SELECTED CS CROSS SECTIONS AS A FUNCTION OF BASIS SET SIZE*

$J \rightarrow J'$		B6	B7	B8	B9	B16	B20
0	1	9.12	8.94	8.93 (10.7)	8.84 (10.7)	(10.7)	(10.7)
0	2	16.2	16.1	16.1 (20.9)	16.2 (21.1)	(21.0)	(21.0)
0	3	3.14	3.21	3.25 (4.37)	3.28 (4.31)	(4.33)	(4.33)
0	4	2.61	2.74	2.76 (3.37)	2.67 (3.21)	(3.25)	(3.24)
0	5	0.32	0.27	0.27 (0.33)	0.25 (0.38)	(0.41)	(0.41)
0	6	0.50	0.30	0.33 (0.35)	0.39 (0.41)	(0.41)	(0.41)
0	7	...	0.09	0.10 (0.18)	0.45 (0.63)	(0.72)	(0.71)
1	2	7.68	7.58	7.51 (9.22)	7.45 (9.17)	(9.13)	(9.12)
1	3	11.5	11.3	11.2 (13.4)	11.2 (13.4)	(13.4)	(13.4)
1	4	1.75	1.86	1.89 (2.29)	1.90 (2.25)	(2.31)	(2.31)
1	5	1.59	1.62	1.66 (1.61)	1.64 (1.61)	(1.70)	(1.71)
1	6	0.42	0.26	0.39 (0.37)	0.43 (0.38)	(0.42)	(0.42)
1	7	...	0.20	0.18 (0.22)	0.19 (0.25)	(0.20)	(0.20)
5	6	12.2	8.29	8.86 (7.86)	9.07 (7.08)	(6.70)	(6.71)
5	7	...	6.04	5.47 (6.69)	6.14 (7.03)	(6.68)	(6.67)
6	7	...	9.87	6.13 (8.21)	4.52 (3.75)	(3.45)	(3.43)

* Cross sections in Å^2 at a total energy of 50 cm^{-1}. Basis set Bn indicates rotor levels to $J = n$ have been included. Values in parentheses are from the coupled states approximation; others are from close-coupling calculations.

c) OCS–H_2 ($J = 0$)

The interaction potential for this system was adapted from an electron gas calculation for OCS–He. The OCS was assumed to be linear and rigid with bond distances $r_{OC} = 2.914$ Bohr radii and $r_{CS} = 2.95$ Bohr radii. The interaction was computed for intermolecular separations $R = 3.0(0.5)9.5$ Bohr radii and for 13 angles $\theta = 0(15)180°$. The angular dependence was fitted to 11 terms in a Legendre polynomial expansion by minimizing the root-mean-square average deviation. The lowest four terms were modified at long range and in the region of the minimum to be in accord with the long-range electrostatic interaction computed from the molecular parameters for OCS and H_2 given in Table 1 (cf. Green and Thaddeus 1976). The final potential is given in Table 4.

Scattering calculations for this system were done only within the coupled states approximation. The reduced mass was taken to be 2.0 amu. Rotational energy levels were computed from the rotational constant $B_0 = 0.20286$ cm^{-1} corrected for a centrifugal distortion constant $D_0 = 4 \times 10^{-8}$ cm^{-1}. Calculations were done with a number of basis sets of increasing size to check for convergence. Final cross sections were obtained with a B22 basis for total energies to 60 cm^{-1} and with a B26 basis for higher energies. These appeared adequate to obtain 10% accuracy for transitions among the lowest 13 rotational levels. Cross sections were averaged over Boltzmann distributions of collision energies to obtain rate constants for kinetic temperatures from 10 K to 100 K, and these are tabulated in the Appendix.

d) HC_3N–He

The interaction between HC_3N and He was computed with the Gordon and Kim (1972) electron gas approximation. The cyanoacetylene was assumed to be linear and rigid with bond distances fixed at the experimental values (Westenberg and Wilson 1950). The potential was computed for 29 orientations at intermolecular separations $R = 4.0(0.5)11.0$ Bohr radii. For larger separations the potential was assumed to decrease as an inverse sixth power at each orientation. (Further details of the potential are available on request from the authors.) As discussed elsewhere (Chapman and Green 1977), because of the large anisotropy of this system it was not possible to expand the potential in a Legendre polynomial series or to perform quantum scattering calculations. Rather, excitation rates were obtained from Monte Carlo quasi-classical trajectory studies.

The initial coordinates and momenta for each batch of trajectories were selected randomly from the appropriate distribution, with the initial rotor energy fixed according to the initial J value using a rotational constant $B_0 = 0.151739$ cm^{-1}; the relative velocity was selected from a thermal distribution at the selected temperature. Thus a batch of trajectories resulted in one row of the matrix $R(J \rightarrow J'|T)$. The equations of motion were integrated with a fourth-order continuously variable step size integrator. The points on the potential energy surface were fitted with a two-dimensional cubic spline function. Final rotation state values were determined by the histogram method.

In most cases, a batch consisted of 5000 trajectories. For the lowest temperature, 10 K, 2000 trajectories were used for the larger J values. The resulting error, as defined by 1 standard deviation in the statistics, ranged from about 5% where the rates were of the order of 10^{-10} cm^3 s^{-1}, to about 25% where the rates were of the order of 10^{-12} cm^3 s^{-1}. Calculations were done for initial rotor levels $J = 0$ through 6, 8, 10, 12, and 15. For other initial levels rates were obtained, where possible, from the reverse transition using microscopic reversibility. The quasi-classical trajectory method does not guarantee microscopic reversibility. Where both forward and reverse rates were computed, however, this condition

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was met within statistical error, but these rates were averaged so as to be in exact detailed balance. The final set of rate constants is given in the Appendix, where values not obtainable as described above have been obtained using the fitting methods discussed in the next section (see especially eq. [2]).

III. FITTING OF RATES

When many rotational levels are accessible, the number of state-to-state rate constants needed to characterize an excitation process becomes unmanageably large, and the question arises whether there is some convenient way of compacting this data, for example, by fitting it to a parametrized form. This question requires, in essence, determining how much information is contained in the set of state-to-state rates—i.e., the irreducible number of independent parameters needed to describe this body of data. An equivalent viewpoint is to consider whether the various rates are interrelated so that knowledge of a few is adequate to determine the others.

It is apparent that the various rates are interrelated to at least some extent. The most obvious example is the detailed balance which is necessitated by time-reversal symmetry, and which gives the relation between forward and reverse rates at temperature T,

$$R(J \to J'|T) = [(2J' + 1)/(2J + 1)] \times \exp(-\Delta E/kT) R(J' \to J|T) , \quad (1)$$

where k is Boltzmann's constant and $\Delta E = E_{J'} - E_J$.

A number of workers have tried to find more general relationships based on other constraints in the physics. No universal fitting formulae have appeared to date, however, and we have therefore chosen to present extensive tables of values. Nonetheless, we will review some of the work along these lines since it may prove useful in using the results presented here; in this context it must be recalled that the acceptability of a fitting formula is always tied to the required accuracy for a given application.

Levine and co-workers (Bernstein and Levine 1972; Levine *et al.* 1976; Procaccia and Levine 1976) have considered this problem from the point of view of information theory. In this approach, one assumes that there is some "statistical" relationship among different rates in the absence of any information or constraints on the dynamics, and this is chosen to be equal probability for all energetically accessible quantum states. Deviations from this "prior" expectation reflect additional dynamical constraints, and a "surprisal" is defined as the negative logarithm of the ratio of actual to prior rate. In general, the surprisal differs for each state-to-state transition; however, by introducing various constraints in the dynamics, it appears that the surprisal may be a simple function of certain collision parameters. For example, for rotational excitation in atom–linear rigid rotor collisions, it has been found for several systems that the surprisal is nearly linear in the fraction of available energy converted from translation to rotation. However, this implies that single-quantum

TABLE 4

INTERACTION POTENTIAL FOR OCS–H_2 ($J = 0$)*

R	v_0	v_1	v_2	v_3	v_4	v_5	v_6	v_7	v_8	v_9	v_{10}
3.0	+98191.71	49216.98	+311831.78	+129728.65	+314260.84	+150855.46	241427.01	120581.42	139875.83	64328.22	41297.23
3.5	+55796.64	52316.06	+183424.77	+117610.50	+178608.27	+129402.44	126313.43	99611.50	66884.27	50015.45	19036.76
4.0	+27402.97	33490.23	+91807.32	+69857.08	+89505.99	+70833.86	65153.49	50336.65	36152.68	24428.69	10809.47
4.5	+11700.69	13630.25	+38763.07	+27762.17	+35056.51	+26346.63	22800.06	17081.35	11471.28	7492.68	3256.49
5.0	+4733.44	5387.20	+16074.63	+11057.72	+13961.95	+10176.85	8240.40	6071.33	3695.75	2438.64	950.15
5.5	+1738.38	1983.04	+6205.09	+4141.41	+4300.85	+3807.87	3051.86	2305.08	1293.20	918.40	328.57
6.0	+528.23	734.57	+2209.20	+1495.94	+1873.45	+1303.27	1042.47	673.96	407.09	280.46	76.56
6.5	+98.40	253.23	+716.01	+488.51	+653.96	+486.11	358.76	259.54	160.14	83.55	41.22
7.0	−35.54	81.21	+181.49	+126.97	+205.58	+144.12	95.54	75.80	21.12	16.27	10.70
7.5	−64.38	32.66	+10.76	+26.78	+58.58	+48.84	38.92	33.12	14.25	8.94	0.00
8.0	−60.56	13.50	−31.39	−5.44	+5.72	+7.68	9.43	8.20	4.27	3.71	0.00
8.5	−49.55	6.76	−24.00	−7.49	−3.91	−1.67	0.95	0.66	0.37	0.30	0.00
9.0	−40.77	4.13	−9.38	−5.40	−4.50	−3.28	0.30	0.29	0.01	0.06	0.00
9.5	−29.48	2.18	−6.78	−3.48	−2.61	−2.10	0.00	0.07	0.00	0.00	0.00

* Distances in Bohr radii, energies in cm^{-1}; the angle $\theta = 0$ corresponds to linear SCO–H_2.

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transitions are always more probable than double-quantum transitions, and the contrary has been found to be true for several systems of astrophysical interest due to symmetry in the interaction potentials, which is ignored in this simple model. (See also Goldflam and Kouri 1976.)

Another approach to this problem notes that, to first order, transitions which change the rotational momentum by ΔJ are induced by the Legendre term, P_λ, in the angle expansion of the potential with $\lambda = \Delta J$. This suggests that all transitions with the same ΔJ may be interrelated. Such an idea was pursued in an empirical fashion by DeJong, Chu, and Dalgarno (1975), who presented a two-parameter fit for each ΔJ which described the dependence on initial level and on collision energy; these authors presented a fit to our earlier results for excitation of CO. More recently DePristo and Rabitz (1977) have pursued a similar idea. By expressing the parameters for a given ΔJ transition in terms of the cross section $\sigma(0 \to J)$ they obtain a formula for computing $\sigma(J \to J')$ in terms of cross sections out of $J = 0$; i.e., if one has one row (or column) of the cross section matrix, the remaining values can be obtained.

Another rather simple formula can be obtained by making the energy sudden approximation—i.e., ignoring the rotational energy differences compared to the collision energy. This method has been discussed in detail recently (Goldflam, Green, and Kouri 1977; Goldflam, Kouri, and Green 1977; Varshalovich and Khersonsky 1976 obtained an identical formula from a different derivation) and tested for a number of systems, including several of those presented here. As expected, this formula becomes quite accurate when many rotational levels are accessible—just the case where a fitting formula is most necessary—since the rotational energy differences are then generally small compared with the collision energy. Like the method of DePristo and Rabitz, this formula can be used to predict the entire matrix of rate constants from knowledge of one row. In terms of the rates of excitation out of the $J = 0$ level it takes the simple form

$$R(J \to J'|T) = (2J' + 1) \times \sum_L \begin{pmatrix} J & L & J' \\ 0 & 0 & 0 \end{pmatrix}^2 R(0 \to L|T)\,, \quad (2)$$

where $(:::)$ is a 3-j angular momentum coupling symbol (Edmonds 1960). Because this formula is derived by ignoring energy differences between rotational levels, it does not satisfy detailed balance, differing from equation (1) by the absence of the energy defect factor, $\exp(-\Delta E/kT)$. It seems reasonable to use equation (2) to compute upward rates from the upward, $0 \to J$ ones, and to obtain the downward rates from detailed balance. (It might be noted that a formula analogous to eq. [2] can be obtained in terms of downward, $J \to 0$ rates. It might be possible to improve somewhat on this fitting procedure by a method that uses as input some average of the $0 \to J$ and $J \to 0$ rates.)

APPENDIX

Computed rates for excitation of CO, CS, OCS, and HC_3N are given in Tables 5, 6, 7, and 8, respectively. Within each table the rates are ordered by initial rotational J value. All rates are given in units of $cm^3\ s^{-1}$ as a function of kinetic temperature. The Monte Carlo statistical sampling used for HC_3N is incapable of accurately determining very small rates; therefore, for this system all rates smaller than $10^{-13}\ cm^3\ s^{-1}$ have been set to zero.

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TABLE 5

COLLISION RATE CONSTANTS (in units of $cm^3\ s^{-1}$) AS A FUNCTION OF KINETIC TEMPERATURE Co–He

INITIAL	-	FINAL	10.0 K	20.0 K	30.0 K	40.0 K	50.0 K	60.0 K	80.0 K	100.0 K
0	-	1	4.9(-11)	5.9(-11)	6.0(-11)	5.9(-11)	5.8(-11)	5.7(-11)	5.6(-11)	5.4(-11)
0	-	2	2.9(-11)	6.2(-11)	7.8(-11)	8.7(-11)	9.2(-11)	9.6(-11)	1.0(-10)	1.0(-10)
0	-	3	8.7(-13)	5.0(-12)	9.3(-12)	1.3(-11)	1.6(-11)	1.9(-11)	2.3(-11)	2.7(-11)
0	-	4	1.6(-13)	2.6(-12)	6.5(-12)	1.0(-11)	1.4(-11)	1.7(-11)	2.2(-11)	2.6(-11)
0	-	5	2.2(-15)	1.7(-13)	8.0(-13)	1.8(-12)	3.1(-12)	4.6(-12)	7.9(-12)	1.1(-11)
0	-	6	1.4(-16)	4.7(-14)	3.4(-13)	9.4(-13)	1.8(-12)	2.9(-12)	5.2(-12)	7.7(-12)
0	-	7	9.4(-19)	3.4(-15)	5.6(-14)	2.4(-13)	5.9(-13)	1.1(-12)	2.4(-12)	3.9(-12)
0	-	8	1.0(-20)	3.3(-16)	1.2(-14)	7.0(-14)	2.1(-13)	4.2(-13)	1.0(-12)	1.7(-12)
0	-	9	1.0(-22)	2.5(-17)	1.9(-15)	1.7(-14)	6.5(-14)	1.6(-13)	4.9(-13)	1.0(-12)
1	-	0	2.8(-11)	2.6(-11)	2.4(-11)	2.3(-11)	2.2(-11)	2.1(-11)	2.0(-11)	1.9(-11)
1	-	2	2.1(-11)	3.5(-11)	4.0(-11)	4.3(-11)	4.4(-11)	4.5(-11)	4.6(-11)	4.7(-11)
1	-	3	8.0(-12)	2.9(-11)	4.3(-11)	5.2(-11)	5.8(-11)	6.2(-11)	6.8(-11)	7.3(-11)
1	-	4	1.3(-13)	1.8(-12)	4.4(-12)	7.1(-12)	9.7(-12)	1.2(-11)	1.6(-11)	1.9(-11)
1	-	5	1.4(-14)	6.8(-13)	2.5(-12)	4.8(-12)	7.1(-12)	9.3(-12)	1.3(-11)	1.6(-11)
1	-	6	1.9(-16)	4.9(-14)	3.3(-13)	9.4(-13)	1.9(-12)	3.1(-12)	6.4(-12)	1.0(-11)
1	-	7	1.8(-18)	5.1(-15)	7.4(-14)	2.9(-13)	6.8(-13)	1.2(-12)	2.4(-12)	3.7(-12)
1	-	8	3.0(-20)	5.6(-16)	1.7(-14)	9.5(-14)	2.7(-13)	5.6(-13)	1.4(-12)	2.4(-12)
1	-	9	1.7(-22)	3.3(-17)	2.3(-15)	2.0(-14)	7.1(-14)	1.6(-13)	4.7(-13)	8.8(-13)
2	-	0	3.0(-11)	2.8(-11)	2.7(-11)	2.6(-11)	2.6(-11)	2.5(-11)	2.5(-11)	2.5(-11)
2	-	1	3.8(-11)	3.7(-11)	3.5(-11)	3.4(-11)	3.3(-11)	3.2(-11)	3.2(-11)	3.2(-11)
2	-	3	8.7(-12)	2.1(-11)	2.7(-11)	3.1(-11)	3.3(-11)	3.5(-11)	3.8(-11)	4.0(-11)
2	-	4	2.3(-12)	1.5(-11)	2.7(-11)	3.6(-11)	4.2(-11)	4.7(-11)	5.5(-11)	6.1(-11)
2	-	5	2.7(-14)	8.3(-13)	2.6(-12)	4.8(-12)	7.0(-12)	9.2(-12)	1.3(-11)	1.7(-11)
2	-	6	1.4(-15)	2.0(-13)	1.0(-12)	2.4(-12)	4.0(-12)	5.7(-12)	9.0(-12)	1.2(-11)
2	-	7	8.5(-18)	1.3(-14)	1.5(-13)	5.3(-13)	1.2(-12)	1.9(-12)	3.8(-12)	5.7(-12)
2	-	8	9.7(-20)	1.1(-15)	2.6(-14)	1.3(-13)	3.6(-13)	7.0(-13)	1.6(-12)	2.5(-12)
2	-	9	8.2(-22)	8.4(-17)	4.8(-15)	3.7(-14)	1.3(-13)	2.8(-13)	8.0(-13)	1.5(-12)
3	-	0	3.4(-12)	3.8(-12)	4.0(-12)	4.2(-12)	4.4(-12)	4.6(-12)	5.0(-12)	5.3(-12)
3	-	1	5.4(-11)	4.9(-11)	4.6(-11)	4.4(-11)	4.3(-11)	4.2(-11)	4.1(-11)	4.1(-11)
3	-	2	3.3(-11)	3.4(-11)	3.3(-11)	3.3(-11)	3.3(-11)	3.3(-11)	3.3(-11)	3.4(-11)
3	-	4	3.1(-12)	1.2(-11)	1.8(-11)	2.2(-11)	2.5(-11)	2.8(-11)	3.1(-11)	3.4(-11)
3	-	5	6.8(-13)	7.8(-12)	1.7(-11)	2.5(-11)	3.1(-11)	3.6(-11)	4.3(-11)	4.9(-11)
3	-	6	6.9(-15)	4.3(-13)	1.7(-12)	3.6(-12)	5.8(-12)	8.3(-12)	1.4(-11)	1.9(-11)
3	-	7	6.8(-17)	4.5(-14)	3.9(-13)	1.2(-12)	2.2(-12)	3.4(-12)	5.9(-12)	8.1(-12)
3	-	8	1.0(-18)	4.6(-15)	7.9(-14)	3.4(-13)	8.1(-13)	1.4(-12)	3.0(-12)	4.6(-12)
3	-	9	4.9(-21)	2.4(-16)	1.1(-14)	7.2(-14)	2.2(-13)	4.6(-13)	1.1(-12)	1.9(-12)
4	-	0	4.5(-12)	4.5(-12)	4.6(-12)	4.6(-12)	4.7(-12)	4.7(-12)	4.9(-12)	5.1(-12)
4	-	1	6.2(-12)	7.1(-12)	7.7(-12)	8.2(-12)	8.7(-12)	9.1(-12)	9.8(-12)	1.0(-11)
4	-	2	6.0(-11)	5.7(-11)	5.4(-11)	5.2(-11)	5.1(-11)	5.0(-11)	5.0(-11)	5.0(-11)
4	-	3	2.2(-11)	2.8(-11)	2.9(-11)	3.0(-11)	3.1(-11)	3.1(-11)	3.2(-11)	3.3(-11)
4	-	5	1.6(-12)	8.2(-12)	1.4(-11)	1.8(-11)	2.2(-11)	2.5(-11)	3.0(-11)	3.4(-11)
4	-	6	2.1(-13)	4.1(-12)	1.1(-11)	1.7(-11)	2.2(-11)	2.7(-11)	3.4(-11)	4.0(-11)
4	-	7	1.0(-15)	2.1(-13)	1.2(-12)	2.8(-12)	4.7(-12)	6.7(-12)	1.0(-11)	1.3(-11)
4	-	8	1.1(-17)	1.7(-14)	2.1(-13)	7.4(-13)	1.6(-12)	2.6(-12)	4.8(-12)	6.8(-12)
4	-	9	7.9(-20)	1.1(-15)	3.3(-14)	1.8(-13)	5.0(-13)	9.6(-13)	2.2(-12)	3.5(-12)

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TABLE 5—*Continued*

INITIAL	-	FINAL	10.0 K	20.0 K	30.0 K	40.0 K	50.0 K	60.0 K	80.0 K	100.0 K
5	-	0	8.2(-13)	9.9(-13)	1.2(-12)	1.3(-12)	1.5(-12)	1.7(-12)	2.0(-12)	2.3(-12)
5	-	1	8.8(-12)	8.9(-12)	9.0(-12)	9.1(-12)	9.2(-12)	9.2(-12)	9.4(-12)	9.5(-12)
5	-	2	9.4(-12)	1.0(-11)	1.1(-11)	1.1(-11)	1.2(-11)	1.3(-11)	1.4(-11)	1.5(-11)
5	-	3	6.3(-11)	6.0(-11)	5.7(-11)	5.5(-11)	5.4(-11)	5.3(-11)	5.1(-11)	5.1(-11)
5	-	4	2.1(-11)	2.7(-11)	2.9(-11)	3.0(-11)	3.1(-11)	3.2(-11)	3.4(-11)	3.7(-11)
5	-	6	1.1(-12)	6.5(-12)	1.2(-11)	1.7(-11)	2.1(-11)	2.4(-11)	3.1(-11)	3.8(-11)
5	-	7	3.1(-14)	1.6(-12)	5.7(-12)	1.1(-11)	1.6(-11)	2.0(-11)	2.7(-11)	3.3(-11)
5	-	8	3.5(-16)	1.2(-13)	8.3(-13)	2.2(-12)	3.9(-12)	5.7(-12)	9.0(-12)	1.2(-11)
5	-	9	1.5(-18)	5.9(-15)	1.1(-13)	4.7(-13)	1.1(-12)	1.9(-12)	3.8(-12)	5.6(-12)
6	-	0	1.2(-12)	1.2(-12)	1.2(-12)	1.3(-12)	1.4(-12)	1.5(-12)	1.7(-12)	1.9(-12)
6	-	1	2.8(-12)	2.9(-12)	3.1(-12)	3.5(-12)	4.0(-12)	4.6(-12)	5.9(-12)	7.2(-12)
6	-	2	1.2(-11)	1.1(-11)	1.1(-11)	1.1(-11)	1.1(-11)	1.1(-11)	1.2(-11)	1.3(-11)
6	-	3	1.5(-11)	1.5(-11)	1.5(-11)	1.6(-11)	1.7(-11)	1.8(-11)	2.1(-11)	2.3(-11)
6	-	4	6.4(-11)	5.9(-11)	5.6(-11)	5.4(-11)	5.2(-11)	5.2(-11)	5.1(-11)	5.1(-11)
6	-	5	2.6(-11)	2.9(-11)	3.0(-11)	3.2(-11)	3.4(-11)	3.6(-11)	4.0(-11)	4.4(-11)
6	-	7	5.7(-13)	5.7(-12)	1.2(-11)	1.7(-11)	2.0(-11)	2.3(-11)	2.7(-11)	2.9(-11)
6	-	8	1.4(-14)	1.0(-12)	4.1(-12)	8.5(-12)	1.3(-11)	1.7(-11)	2.4(-11)	2.9(-11)
6	-	9	6.4(-17)	4.4(-14)	4.5(-13)	1.4(-12)	2.9(-12)	4.4(-12)	7.4(-12)	1.0(-11)
7	-	0	3.4(-13)	5.3(-13)	6.5(-13)	7.7(-13)	8.7(-13)	9.6(-13)	1.1(-12)	1.2(-12)
7	-	1	1.1(-12)	1.8(-12)	2.2(-12)	2.5(-12)	2.7(-12)	2.9(-12)	3.1(-12)	3.3(-12)
7	-	2	2.9(-12)	4.4(-12)	5.1(-12)	5.6(-12)	6.1(-12)	6.5(-12)	7.1(-12)	7.6(-12)
7	-	3	6.2(-12)	9.3(-12)	1.1(-11)	1.1(-11)	1.2(-11)	1.2(-11)	1.3(-11)	1.3(-11)
7	-	4	1.3(-11)	1.8(-11)	2.0(-11)	2.0(-11)	2.1(-11)	2.1(-11)	2.1(-11)	2.1(-11)
7	-	5	3.0(-11)	4.3(-11)	4.6(-11)	4.8(-11)	4.9(-11)	4.9(-11)	5.0(-11)	4.9(-11)
7	-	6	2.4(-11)	3.4(-11)	3.7(-11)	3.8(-11)	3.8(-11)	3.8(-11)	3.8(-11)	3.8(-11)
7	-	8	4.9(-13)	4.6(-12)	9.8(-12)	1.4(-11)	1.8(-11)	2.0(-11)	2.4(-11)	2.6(-11)
7	-	9	5.1(-15)	5.6(-13)	3.1(-12)	7.3(-12)	1.2(-11)	1.6(-11)	2.3(-11)	2.9(-11)
8	-	0	2.8(-13)	4.1(-13)	5.2(-13)	6.0(-13)	6.6(-13)	6.9(-13)	7.3(-13)	7.4(-13)
8	-	1	1.4(-12)	1.6(-12)	1.9(-12)	2.1(-12)	2.3(-12)	2.5(-12)	2.8(-12)	3.0(-12)
8	-	2	2.4(-12)	2.9(-12)	3.4(-12)	3.8(-12)	4.1(-12)	4.3(-12)	4.6(-12)	4.6(-12)
8	-	3	7.0(-12)	7.6(-12)	8.3(-12)	8.8(-12)	9.2(-12)	9.4(-12)	9.7(-12)	9.9(-12)
8	-	4	1.1(-11)	1.2(-11)	1.3(-11)	1.4(-11)	1.5(-11)	1.5(-11)	1.5(-11)	1.5(-11)
8	-	5	2.5(-11)	2.6(-11)	2.6(-11)	2.6(-11)	2.6(-11)	2.6(-11)	2.5(-11)	2.4(-11)
8	-	6	4.5(-11)	4.9(-11)	5.0(-11)	5.2(-11)	5.2(-11)	5.2(-11)	5.2(-11)	5.1(-11)
8	-	7	3.6(-11)	3.7(-11)	3.8(-11)	3.8(-11)	3.8(-11)	3.8(-11)	3.7(-11)	3.6(-11)
8	-	9	2.2(-13)	2.4(-12)	6.4(-12)	1.1(-11)	1.4(-11)	1.7(-11)	2.0(-11)	2.2(-11)
9	-	0	3.5(-13)	3.3(-13)	4.0(-13)	4.6(-13)	5.0(-13)	5.2(-13)	5.8(-13)	6.5(-13)
9	-	1	1.0(-12)	1.0(-12)	1.2(-12)	1.4(-12)	1.5(-12)	1.5(-12)	1.5(-12)	1.6(-12)
9	-	2	2.7(-12)	2.5(-12)	2.9(-12)	3.3(-12)	3.5(-12)	3.6(-12)	3.8(-12)	4.1(-12)
9	-	3	4.3(-12)	4.3(-12)	5.3(-12)	5.9(-12)	6.2(-12)	6.2(-12)	6.2(-12)	6.1(-12)
9	-	4	9.8(-12)	8.7(-12)	1.0(-11)	1.1(-11)	1.1(-11)	1.2(-11)	1.2(-11)	1.2(-11)
9	-	5	1.4(-11)	1.4(-11)	1.6(-11)	1.7(-11)	1.8(-11)	1.8(-11)	1.7(-11)	1.7(-11)
9	-	6	2.6(-11)	2.3(-11)	2.6(-11)	2.7(-11)	2.8(-11)	2.8(-11)	2.7(-11)	2.6(-11)
9	-	7	4.9(-11)	4.9(-11)	5.6(-11)	6.1(-11)	6.2(-11)	6.2(-11)	6.0(-11)	5.8(-11)
9	-	8	2.8(-11)	2.6(-11)	3.0(-11)	3.3(-11)	3.4(-11)	3.4(-11)	3.4(-11)	3.3(-11)

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TABLE 6

COLLISION RATE CONSTANTS (in units of $cm^3 s^{-1}$) AS A FUNCTION OF KINETIC TEMPERATURE CS–H_2 ($J = 0$)

INITIAL	-	FINAL	10.0 K	20.0 K	40.0 K	60.0 K	80.0 K	100.0 K
0	-	1	4.4(-11)	5.9(-11)	6.9(-11)	7.2(-11)	7.3(-11)	7.3(-11)
0	-	2	5.0(-11)	8.4(-11)	1.2(-10)	1.3(-10)	1.4(-10)	1.5(-10)
0	-	3	5.7(-12)	1.4(-11)	2.3(-11)	2.8(-11)	3.1(-11)	3.3(-11)
0	-	4	2.0(-12)	7.7(-12)	1.7(-11)	2.4(-11)	2.9(-11)	3.3(-11)
0	-	5	1.5(-13)	8.5(-13)	2.7(-12)	4.7(-12)	6.5(-12)	8.2(-12)
0	-	6	3.3(-14)	5.3(-13)	2.9(-12)	6.0(-12)	9.2(-12)	1.2(-11)
0	-	7	2.0(-14)	4.6(-13)	2.0(-12)	3.4(-12)	4.6(-12)	5.7(-12)
0	-	8	5.5(-16)	4.4(-14)	4.6(-13)	1.2(-12)	2.3(-12)	3.5(-12)
0	-	9	3.0(-16)	6.0(-14)	7.8(-13)	1.9(-12)	3.1(-12)	4.3(-12)
0	-	10	7.7(-18)	5.1(-15)	1.4(-13)	4.7(-13)	9.4(-13)	1.5(-12)
0	-	11	6.4(-19)	1.5(-15)	7.5(-14)	3.1(-13)	6.8(-13)	1.2(-12)
0	-	12	2.4(-20)	2.6(-16)	2.8(-14)	1.5(-13)	3.7(-13)	6.8(-13)
1	-	0	1.8(-11)	2.2(-11)	2.5(-11)	2.5(-11)	2.5(-11)	2.5(-11)
1	-	2	3.0(-11)	4.6(-11)	5.7(-11)	6.1(-11)	6.3(-11)	6.3(-11)
1	-	3	2.6(-11)	5.2(-11)	7.8(-11)	8.9(-11)	9.6(-11)	1.0(-10)
1	-	4	2.0(-12)	6.4(-12)	1.3(-11)	1.7(-11)	2.0(-11)	2.1(-11)
1	-	5	5.2(-13)	3.3(-12)	9.7(-12)	1.5(-11)	2.0(-11)	2.3(-11)
1	-	6	5.2(-14)	6.0(-13)	2.3(-12)	4.0(-12)	5.6(-12)	7.0(-12)
1	-	7	9.6(-15)	2.5(-13)	1.6(-12)	3.7(-12)	5.9(-12)	8.0(-12)
1	-	8	3.1(-15)	1.8(-13)	1.3(-12)	2.6(-12)	3.9(-12)	5.0(-12)
1	-	9	1.0(-16)	1.9(-14)	2.9(-13)	8.6(-13)	1.6(-12)	2.5(-12)
1	-	10	2.5(-17)	1.3(-14)	3.1(-13)	9.3(-13)	1.7(-12)	2.5(-12)
1	-	11	5.9(-19)	1.3(-15)	6.7(-14)	2.8(-13)	6.2(-13)	1.1(-12)
1	-	12	3.6(-20)	3.3(-16)	3.3(-14)	1.7(-13)	4.1(-13)	7.4(-13)
2	-	0	2.0(-11)	2.4(-11)	2.8(-11)	2.9(-11)	3.0(-11)	3.1(-11)
2	-	1	2.9(-11)	3.5(-11)	3.9(-11)	4.0(-11)	4.0(-11)	4.0(-11)
2	-	3	3.2(-11)	4.6(-11)	5.3(-11)	5.5(-11)	5.6(-11)	5.7(-11)
2	-	4	1.5(-11)	3.7(-11)	5.9(-11)	6.9(-11)	7.7(-11)	8.2(-11)
2	-	5	9.2(-13)	4.3(-12)	9.8(-12)	1.3(-11)	1.6(-11)	1.8(-11)
2	-	6	2.2(-13)	2.0(-12)	6.8(-12)	1.1(-11)	1.5(-11)	1.8(-11)
2	-	7	2.7(-14)	4.8(-13)	2.1(-12)	3.7(-12)	5.3(-12)	6.7(-12)
2	-	8	3.1(-15)	1.5(-13)	1.2(-12)	2.8(-12)	4.6(-12)	6.4(-12)
2	-	9	4.4(-16)	6.1(-14)	6.8(-13)	1.6(-12)	2.5(-12)	3.5(-12)
2	-	10	1.7(-17)	7.8(-15)	1.8(-13)	6.1(-13)	1.2(-12)	2.0(-12)
2	-	11	2.6(-18)	4.1(-15)	1.6(-13)	5.7(-13)	1.1(-12)	1.8(-12)
2	-	12	4.4(-20)	3.4(-16)	3.1(-14)	1.6(-13)	4.0(-13)	7.2(-13)
3	-	0	3.3(-12)	3.9(-12)	4.6(-12)	5.0(-12)	5.2(-12)	5.4(-12)
3	-	1	3.6(-11)	4.0(-11)	4.5(-11)	4.7(-11)	4.8(-11)	4.9(-11)
3	-	2	4.6(-11)	4.7(-11)	4.5(-11)	4.4(-11)	4.4(-11)	4.3(-11)
3	-	4	2.3(-11)	3.9(-11)	4.8(-11)	5.1(-11)	5.2(-11)	5.3(-11)
3	-	5	8.1(-12)	2.6(-11)	4.6(-11)	5.6(-11)	6.3(-11)	6.9(-11)
3	-	6	4.9(-13)	3.0(-12)	8.0(-12)	1.2(-11)	1.4(-11)	1.6(-11)
3	-	7	8.5(-14)	1.2(-12)	5.1(-12)	8.8(-12)	1.2(-11)	1.5(-11)
3	-	8	7.4(-15)	2.3(-13)	1.4(-12)	2.7(-12)	4.0(-12)	5.2(-12)
3	-	9	6.9(-16)	7.4(-14)	8.5(-13)	2.2(-12)	3.7(-12)	5.2(-12)
3	-	10	7.1(-17)	2.2(-14)	3.9(-13)	1.0(-12)	1.8(-12)	2.6(-12)
3	-	11	2.3(-18)	2.8(-15)	1.1(-13)	4.2(-13)	9.1(-13)	1.5(-12)
3	-	12	2.5(-19)	1.2(-15)	8.5(-14)	3.7(-13)	7.9(-13)	1.3(-12)

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TABLE 6—*Continued*

INITIAL	-	FINAL	10.0 K	20.0 K	40.0 K	60.0 K	80.0 K	100.0 K
4	-	0	2.3(-12)	2.8(-12)	3.5(-12)	4.0(-12)	4.4(-12)	4.7(-12)
4	-	1	5.5(-12)	6.2(-12)	7.2(-12)	7.9(-12)	8.5(-12)	8.8(-12)
4	-	2	4.3(-11)	4.7(-11)	4.9(-11)	5.1(-11)	5.2(-11)	5.4(-11)
4	-	3	4.6(-11)	4.9(-11)	4.7(-11)	4.6(-11)	4.5(-11)	4.5(-11)
4	-	5	1.2(-11)	2.7(-11)	3.9(-11)	4.4(-11)	4.7(-11)	4.8(-11)
4	-	6	5.2(-12)	1.9(-11)	3.7(-11)	4.8(-11)	5.5(-11)	6.1(-11)
4	-	7	2.4(-13)	2.1(-12)	6.4(-12)	9.6(-12)	1.2(-11)	1.4(-11)
4	-	8	3.6(-14)	8.2(-13)	4.1(-12)	7.6(-12)	1.1(-11)	1.3(-11)
4	-	9	1.5(-15)	1.0(-13)	8.9(-13)	2.0(-12)	3.2(-12)	4.3(-12)
4	-	10	1.9(-16)	3.9(-14)	6.1(-13)	1.7(-12)	3.0(-12)	4.4(-12)
4	-	11	1.4(-17)	9.7(-15)	2.5(-13)	7.6(-13)	1.4(-12)	2.1(-12)
4	-	12	3.9(-19)	1.3(-15)	7.3(-14)	3.2(-13)	7.3(-13)	1.2(-12)
5	-	0	4.5(-13)	4.5(-13)	5.8(-13)	7.6(-13)	9.2(-13)	1.1(-12)
5	-	1	3.8(-12)	4.7(-12)	6.0(-12)	7.1(-12)	8.1(-12)	8.8(-12)
5	-	2	7.0(-12)	8.0(-12)	9.0(-12)	9.8(-12)	1.0(-11)	1.1(-11)
5	-	3	4.3(-11)	4.8(-11)	4.9(-11)	5.1(-11)	5.3(-11)	5.4(-11)
5	-	4	3.3(-11)	4.0(-11)	4.3(-11)	4.4(-11)	4.4(-11)	4.4(-11)
5	-	6	1.2(-11)	2.6(-11)	3.7(-11)	4.2(-11)	4.5(-11)	4.6(-11)
5	-	7	3.5(-12)	1.5(-11)	3.2(-11)	4.3(-11)	5.0(-11)	5.6(-11)
5	-	8	1.3(-13)	1.6(-12)	5.5(-12)	8.6(-12)	1.1(-11)	1.3(-11)
5	-	9	1.4(-14)	5.1(-13)	3.3(-12)	6.4(-12)	9.2(-12)	1.2(-11)
5	-	10	5.0(-16)	5.9(-14)	6.7(-13)	1.7(-12)	2.7(-12)	3.8(-12)
5	-	11	4.7(-17)	2.0(-14)	4.5(-13)	1.4(-12)	2.6(-12)	3.8(-12)
5	-	12	2.2(-18)	3.8(-15)	1.5(-13)	5.4(-13)	1.1(-12)	1.7(-12)
6	-	0	3.6(-13)	4.8(-13)	7.6(-13)	1.1(-12)	1.3(-12)	1.5(-12)
6	-	1	1.3(-12)	1.5(-12)	1.7(-12)	2.0(-12)	2.3(-12)	2.6(-12)
6	-	2	5.7(-12)	6.3(-12)	7.5(-12)	8.6(-12)	9.6(-12)	1.1(-11)
6	-	3	9.0(-12)	9.4(-12)	1.0(-11)	1.1(-11)	1.2(-11)	1.2(-11)
6	-	4	4.8(-11)	4.9(-11)	4.9(-11)	5.1(-11)	5.3(-11)	5.5(-11)
6	-	5	4.1(-11)	4.5(-11)	4.5(-11)	4.5(-11)	4.5(-11)	4.5(-11)
6	-	7	6.2(-12)	1.7(-11)	3.0(-11)	3.6(-11)	4.0(-11)	4.2(-11)
6	-	8	2.0(-12)	1.2(-11)	2.8(-11)	3.8(-11)	4.6(-11)	5.2(-11)
6	-	9	5.3(-14)	1.0(-12)	4.3(-12)	7.3(-12)	9.6(-12)	1.1(-11)
6	-	10	6.6(-15)	3.6(-13)	2.7(-12)	5.6(-12)	8.3(-12)	1.1(-11)
6	-	11	1.6(-16)	3.4(-14)	5.2(-13)	1.4(-12)	2.4(-12)	3.4(-12)
6	-	12	1.3(-17)	1.1(-14)	3.4(-13)	1.2(-12)	2.2(-12)	3.4(-12)
7	-	0	9.5(-13)	8.2(-13)	7.0(-13)	6.8(-13)	7.0(-13)	7.3(-13)
7	-	1	1.1(-12)	1.2(-12)	1.6(-12)	2.1(-12)	2.6(-12)	3.0(-12)
7	-	2	3.2(-12)	3.0(-12)	3.0(-12)	3.3(-12)	3.7(-12)	4.0(-12)
7	-	3	7.0(-12)	7.4(-12)	8.6(-12)	9.8(-12)	1.1(-11)	1.2(-11)
7	-	4	1.0(-11)	1.0(-11)	1.1(-11)	1.2(-11)	1.2(-11)	1.3(-11)
7	-	5	5.5(-11)	5.2(-11)	5.1(-11)	5.2(-11)	5.4(-11)	5.6(-11)
7	-	6	2.8(-11)	3.4(-11)	3.9(-11)	4.1(-11)	4.2(-11)	4.3(-11)
7	-	8	5.7(-12)	1.8(-11)	3.1(-11)	3.6(-11)	4.0(-11)	4.2(-11)
7	-	9	1.4(-12)	1.0(-11)	2.6(-11)	3.6(-11)	4.3(-11)	4.9(-11)
7	-	10	3.1(-14)	7.6(-13)	3.8(-12)	6.6(-12)	8.9(-12)	1.1(-11)
7	-	11	2.7(-15)	2.4(-13)	2.3(-12)	5.1(-12)	7.7(-12)	9.9(-12)
7	-	12	5.2(-17)	2.0(-14)	3.9(-13)	1.2(-12)	2.0(-12)	2.9(-12)

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TABLE 6—*Continued*

INITIAL	-	FINAL	10.0 K	20.0 K	40.0 K	60.0 K	80.0 K	100.0 K
8	-	0	1.5(-13)	1.8(-13)	2.2(-13)	3.0(-13)	3.9(-13)	4.8(-13)
8	-	1	2.1(-12)	2.0(-12)	1.8(-12)	1.8(-12)	1.9(-12)	2.0(-12)
8	-	2	2.1(-12)	2.2(-12)	2.5(-12)	3.0(-12)	3.6(-12)	4.1(-12)
8	-	3	3.6(-12)	3.3(-12)	3.3(-12)	3.6(-12)	4.0(-12)	4.4(-12)
8	-	4	8.5(-12)	9.2(-12)	1.0(-11)	1.1(-11)	1.2(-11)	1.3(-11)
8	-	5	1.2(-11)	1.2(-11)	1.2(-11)	1.3(-11)	1.3(-11)	1.4(-11)
8	-	6	5.2(-11)	5.3(-11)	5.2(-11)	5.3(-11)	5.4(-11)	5.6(-11)
8	-	7	3.3(-11)	4.1(-11)	4.3(-11)	4.4(-11)	4.4(-11)	4.5(-11)
8	-	9	4.4(-12)	1.5(-11)	2.8(-11)	3.4(-11)	3.8(-11)	4.0(-11)
8	-	10	1.0(-12)	8.7(-12)	2.4(-11)	3.4(-11)	4.1(-11)	4.7(-11)
8	-	11	1.6(-14)	5.7(-13)	3.3(-12)	6.0(-12)	8.2(-12)	1.0(-11)
8	-	12	1.2(-15)	1.7(-13)	2.0(-12)	4.6(-12)	7.1(-12)	9.3(-12)
9	-	0	5.3(-13)	6.2(-13)	5.8(-13)	5.9(-13)	6.1(-13)	6.5(-13)
9	-	1	4.9(-13)	5.4(-13)	6.1(-13)	7.6(-13)	9.4(-13)	1.1(-12)
9	-	2	2.2(-12)	2.2(-12)	2.1(-12)	2.2(-12)	2.3(-12)	2.5(-12)
9	-	3	2.5(-12)	2.7(-12)	3.1(-12)	3.7(-12)	4.3(-12)	4.8(-12)
9	-	4	2.6(-12)	2.9(-12)	3.3(-12)	3.8(-12)	4.2(-12)	4.7(-12)
9	-	5	9.2(-12)	1.0(-11)	1.1(-11)	1.2(-11)	1.3(-11)	1.4(-11)
9	-	6	1.0(-11)	1.2(-11)	1.2(-11)	1.3(-11)	1.3(-11)	1.4(-11)
9	-	7	5.9(-11)	5.9(-11)	5.6(-11)	5.5(-11)	5.6(-11)	5.8(-11)
9	-	8	3.3(-11)	4.0(-11)	4.2(-11)	4.3(-11)	4.4(-11)	4.4(-11)
9	-	10	3.9(-12)	1.4(-11)	2.7(-11)	3.3(-11)	3.7(-11)	3.9(-11)
9	-	11	6.9(-13)	7.7(-12)	2.3(-11)	3.4(-11)	4.1(-11)	4.6(-11)
9	-	12	8.2(-15)	4.1(-13)	2.7(-12)	5.2(-12)	7.3(-12)	9.0(-12)
10	-	0	1.5(-13)	1.6(-13)	1.7(-13)	1.9(-13)	2.2(-13)	2.6(-13)
10	-	1	1.1(-12)	1.1(-12)	1.1(-12)	1.1(-12)	1.2(-12)	1.3(-12)
10	-	2	8.4(-13)	8.4(-13)	9.2(-13)	1.1(-12)	1.3(-12)	1.6(-12)
10	-	3	2.4(-12)	2.4(-12)	2.3(-12)	2.4(-12)	2.6(-12)	2.8(-12)
10	-	4	3.2(-12)	3.3(-12)	3.7(-12)	4.3(-12)	4.9(-12)	5.4(-12)
10	-	5	3.2(-12)	3.3(-12)	3.7(-12)	4.2(-12)	4.6(-12)	5.1(-12)
10	-	6	1.2(-11)	1.2(-11)	1.2(-11)	1.3(-11)	1.4(-11)	1.5(-11)
10	-	7	1.3(-11)	1.3(-11)	1.3(-11)	1.4(-11)	1.4(-11)	1.5(-11)
10	-	8	7.1(-11)	6.6(-11)	6.0(-11)	5.8(-11)	5.8(-11)	5.9(-11)
10	-	9	3.7(-11)	4.2(-11)	4.4(-11)	4.4(-11)	4.4(-11)	4.5(-11)
10	-	11	3.1(-12)	1.2(-11)	2.4(-11)	3.1(-11)	3.5(-11)	3.8(-11)
10	-	12	4.4(-13)	6.5(-12)	2.2(-11)	3.2(-11)	4.0(-11)	4.5(-11)
11	-	0	1.5(-13)	1.5(-13)	1.6(-13)	1.8(-13)	2.1(-13)	2.4(-13)
11	-	1	3.4(-13)	3.6(-13)	4.0(-13)	4.7(-13)	5.5(-13)	6.3(-13)
11	-	2	1.5(-12)	1.5(-12)	1.4(-12)	1.5(-12)	1.6(-12)	1.7(-12)
11	-	3	9.5(-13)	9.9(-13)	1.1(-12)	1.3(-12)	1.6(-12)	1.9(-12)
11	-	4	2.8(-12)	2.8(-12)	2.6(-12)	2.7(-12)	2.9(-12)	3.0(-12)
11	-	5	3.7(-12)	3.9(-12)	4.3(-12)	4.9(-12)	5.5(-12)	6.1(-12)
11	-	6	3.5(-12)	3.8(-12)	4.2(-12)	4.6(-12)	5.1(-12)	5.5(-12)
11	-	7	1.3(-11)	1.4(-11)	1.4(-11)	1.5(-11)	1.5(-11)	1.6(-11)
11	-	8	1.4(-11)	1.4(-11)	1.4(-11)	1.4(-11)	1.5(-11)	1.5(-11)
11	-	9	7.9(-11)	7.5(-11)	6.7(-11)	6.3(-11)	6.2(-11)	6.3(-11)
11	-	10	3.7(-11)	4.1(-11)	4.2(-11)	4.3(-11)	4.4(-11)	4.5(-11)
11	-	12	2.4(-12)	1.0(-11)	2.2(-11)	2.8(-11)	3.3(-11)	3.6(-11)

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TABLE 6—*Continued*

INITIAL	-	FINAL	10.0 K	20.0 K	40.0 K	60.0 K	80.0 K	100.0 K
12	-	0	8.8(-14)	9.9(-14)	1.1(-13)	1.3(-13)	1.5(-13)	1.7(-13)
12	-	1	3.2(-13)	3.4(-13)	3.6(-13)	4.1(-13)	4.7(-13)	5.4(-13)
12	-	2	4.1(-13)	4.6(-13)	5.1(-13)	6.1(-13)	7.2(-13)	8.4(-13)
12	-	3	1.6(-12)	1.7(-12)	1.6(-12)	1.7(-12)	1.8(-12)	2.0(-12)
12	-	4	1.3(-12)	1.4(-12)	1.4(-12)	1.7(-12)	1.9(-12)	2.2(-12)
12	-	5	2.7(-12)	2.8(-12)	2.7(-12)	2.8(-12)	3.0(-12)	3.2(-12)
12	-	6	4.4(-12)	4.8(-12)	5.1(-12)	5.7(-12)	6.2(-12)	6.7(-12)
12	-	7	4.0(-12)	4.2(-12)	4.5(-12)	4.9(-12)	5.3(-12)	5.7(-12)
12	-	8	1.5(-11)	1.6(-11)	1.6(-11)	1.6(-11)	1.7(-11)	1.7(-11)
12	-	9	1.5(-11)	1.5(-11)	1.4(-11)	1.4(-11)	1.5(-11)	1.5(-11)
12	-	10	8.3(-11)	8.2(-11)	7.2(-11)	6.7(-11)	6.6(-11)	6.5(-11)
12	-	11	3.8(-11)	3.9(-11)	4.0(-11)	4.2(-11)	4.3(-11)	4.4(-11)

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TABLE 7

COLLISION RATE CONSTANTS (in units of $cm^3 s^{-1}$) AS A FUNCTION OF KINETIC TEMPERATURE OCS–H_2 ($J = 0$)

INITIAL	-	FINAL	10.0 K	20.0 K	40.0 K	60.0 K	80.0 K	100.0 K
0	-	1	1.1(-10)	1.0(-10)	1.0(-10)	1.0(-10)	9.9(-11)	9.7(-11)
0	-	2	2.3(-10)	2.5(-10)	2.6(-10)	2.6(-10)	2.6(-10)	2.6(-10)
0	-	3	3.0(-11)	4.6(-11)	6.9(-11)	7.9(-11)	8.4(-11)	8.6(-11)
0	-	4	8.8(-11)	1.2(-10)	1.3(-10)	1.3(-10)	1.3(-10)	1.3(-10)
0	-	5	1.5(-11)	2.5(-11)	3.4(-11)	3.8(-11)	4.0(-11)	4.2(-11)
0	-	6	1.5(-11)	2.8(-11)	4.3(-11)	5.3(-11)	6.0(-11)	6.5(-11)
0	-	7	4.4(-12)	8.9(-12)	1.2(-11)	1.3(-11)	1.4(-11)	1.5(-11)
0	-	8	3.4(-12)	1.0(-11)	1.8(-11)	2.4(-11)	2.9(-11)	3.3(-11)
0	-	9	1.6(-12)	5.2(-12)	8.9(-12)	1.0(-11)	1.1(-11)	1.2(-11)
0	-	10	8.6(-13)	4.2(-12)	9.0(-12)	1.2(-11)	1.4(-11)	1.6(-11)
0	-	11	8.2(-13)	5.8(-12)	1.4(-11)	1.9(-11)	2.1(-11)	2.2(-11)
0	-	12	1.6(-13)	1.3(-12)	3.3(-12)	4.6(-12)	5.6(-12)	6.6(-12)
1	-	0	3.9(-11)	3.6(-11)	3.4(-11)	3.4(-11)	3.3(-11)	3.3(-11)
1	-	2	8.2(-11)	8.8(-11)	9.7(-11)	1.0(-10)	1.0(-10)	1.0(-10)
1	-	3	1.9(-10)	2.1(-10)	2.1(-10)	2.2(-10)	2.1(-10)	2.1(-10)
1	-	4	2.6(-11)	4.2(-11)	5.9(-11)	6.6(-11)	6.9(-11)	7.0(-11)
1	-	5	5.2(-11)	7.5(-11)	9.2(-11)	9.9(-11)	1.0(-10)	1.0(-10)
1	-	6	9.6(-12)	1.7(-11)	2.3(-11)	2.6(-11)	2.8(-11)	3.0(-11)
1	-	7	9.6(-12)	2.1(-11)	3.3(-11)	4.0(-11)	4.6(-11)	5.1(-11)
1	-	8	2.9(-12)	7.3(-12)	1.1(-11)	1.2(-11)	1.3(-11)	1.4(-11)
1	-	9	2.3(-12)	7.7(-12)	1.4(-11)	1.8(-11)	2.2(-11)	2.5(-11)
1	-	10	1.2(-12)	5.6(-12)	1.1(-11)	1.4(-11)	1.6(-11)	1.7(-11)
1	-	11	3.7(-13)	2.5(-12)	6.1(-12)	8.3(-12)	1.0(-11)	1.2(-11)
1	-	12	4.0(-13)	4.0(-12)	1.2(-11)	1.7(-11)	2.0(-11)	2.2(-11)
2	-	0	5.5(-11)	5.5(-11)	5.5(-11)	5.4(-11)	5.4(-11)	5.3(-11)
2	-	1	5.5(-11)	5.6(-11)	6.0(-11)	6.2(-11)	6.3(-11)	6.2(-11)
2	-	3	8.1(-11)	8.7(-11)	9.4(-11)	9.7(-11)	9.7(-11)	9.7(-11)
2	-	4	1.4(-10)	1.6(-10)	1.8(-10)	1.8(-10)	1.9(-10)	1.9(-10)
2	-	5	1.9(-11)	3.1(-11)	4.6(-11)	5.2(-11)	5.5(-11)	5.7(-11)
2	-	6	3.5(-11)	5.7(-11)	7.4(-11)	8.1(-11)	8.4(-11)	8.6(-11)
2	-	7	6.2(-12)	1.3(-11)	1.9(-11)	2.2(-11)	2.4(-11)	2.6(-11)
2	-	8	5.6(-12)	1.5(-11)	2.6(-11)	3.3(-11)	3.8(-11)	4.2(-11)
2	-	9	2.4(-12)	7.7(-12)	1.3(-11)	1.5(-11)	1.7(-11)	1.8(-11)
2	-	10	1.0(-12)	4.6(-12)	9.8(-12)	1.3(-11)	1.6(-11)	1.9(-11)
2	-	11	7.6(-13)	4.9(-12)	1.2(-11)	1.5(-11)	1.7(-11)	1.9(-11)
2	-	12	2.3(-13)	2.0(-12)	5.3(-12)	7.4(-12)	9.0(-12)	1.0(-11)
3	-	0	6.0(-12)	7.8(-12)	1.1(-11)	1.2(-11)	1.3(-11)	1.3(-11)
3	-	1	1.1(-10)	1.0(-10)	9.9(-11)	9.7(-11)	9.6(-11)	9.4(-11)
3	-	2	6.9(-11)	6.8(-11)	7.0(-11)	7.1(-11)	7.1(-11)	7.0(-11)
3	-	4	6.3(-11)	7.2(-11)	8.2(-11)	8.6(-11)	8.8(-11)	8.8(-11)
3	-	5	1.2(-10)	1.5(-10)	1.6(-10)	1.7(-10)	1.7(-10)	1.7(-10)
3	-	6	1.8(-11)	3.0(-11)	4.4(-11)	4.9(-11)	5.2(-11)	5.3(-11)
3	-	7	2.5(-11)	4.7(-11)	6.4(-11)	7.1(-11)	7.4(-11)	7.6(-11)
3	-	8	5.3(-12)	1.3(-11)	2.1(-11)	2.5(-11)	2.6(-11)	2.8(-11)
3	-	9	3.8(-12)	1.2(-11)	2.1(-11)	2.7(-11)	3.2(-11)	3.5(-11)
3	-	10	1.6(-12)	6.6(-12)	1.3(-11)	1.6(-11)	1.8(-11)	1.9(-11)
3	-	11	6.4(-13)	3.7(-12)	8.6(-12)	1.2(-11)	1.5(-11)	1.7(-11)
3	-	12	4.0(-13)	3.2(-12)	8.8(-12)	1.2(-11)	1.4(-11)	1.6(-11)

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TABLE 7—*Continued*

INITIAL	-	FINAL	10.0 K	20.0 K	40.0 K	60.0 K	80.0 K	100.0 K
4	-	0	1.8(-11)	1.7(-11)	1.7(-11)	1.6(-11)	1.6(-11)	1.6(-11)
4	-	1	1.5(-11)	1.8(-11)	2.2(-11)	2.4(-11)	2.5(-11)	2.5(-11)
4	-	2	1.2(-10)	1.1(-10)	1.1(-10)	1.1(-10)	1.1(-10)	1.1(-10)
4	-	3	6.2(-11)	6.3(-11)	6.8(-11)	7.0(-11)	7.0(-11)	7.0(-11)
4	-	5	6.7(-11)	7.6(-11)	8.4(-11)	8.7(-11)	8.8(-11)	8.7(-11)
4	-	6	1.0(-10)	1.3(-10)	1.5(-10)	1.5(-10)	1.6(-10)	1.6(-10)
4	-	7	1.6(-11)	2.9(-11)	4.3(-11)	4.9(-11)	5.2(-11)	5.3(-11)
4	-	8	1.8(-11)	4.0(-11)	5.7(-11)	6.4(-11)	6.7(-11)	6.9(-11)
4	-	9	3.9(-12)	1.1(-11)	2.0(-11)	2.4(-11)	2.6(-11)	2.8(-11)
4	-	10	2.4(-12)	9.4(-12)	1.9(-11)	2.5(-11)	2.9(-11)	3.2(-11)
4	-	11	9.2(-13)	4.9(-12)	1.1(-11)	1.4(-11)	1.5(-11)	1.7(-11)
4	-	12	4.0(-13)	3.0(-12)	7.9(-12)	1.2(-11)	1.5(-11)	1.7(-11)
5	-	0	3.3(-12)	3.5(-12)	3.8(-12)	4.0(-12)	4.1(-12)	4.2(-12)
5	-	1	3.2(-11)	3.1(-11)	3.1(-11)	3.1(-11)	3.1(-11)	3.0(-11)
5	-	2	1.7(-11)	2.0(-11)	2.5(-11)	2.7(-11)	2.7(-11)	2.8(-11)
5	-	3	1.3(-10)	1.2(-10)	1.2(-10)	1.2(-10)	1.1(-10)	1.1(-10)
5	-	4	7.3(-11)	7.2(-11)	7.4(-11)	7.5(-11)	7.4(-11)	7.3(-11)
5	-	6	6.1(-11)	7.1(-11)	8.2(-11)	8.6(-11)	8.7(-11)	8.7(-11)
5	-	7	8.2(-11)	1.2(-10)	1.4(-10)	1.4(-10)	1.5(-10)	1.5(-10)
5	-	8	1.4(-11)	2.7(-11)	4.1(-11)	4.8(-11)	5.1(-11)	5.3(-11)
5	-	9	1.4(-11)	3.5(-11)	5.3(-11)	6.0(-11)	6.3(-11)	6.5(-11)
5	-	10	2.8(-12)	9.6(-12)	1.7(-11)	2.1(-11)	2.4(-11)	2.6(-11)
5	-	11	1.7(-12)	7.7(-12)	1.7(-11)	2.3(-11)	2.7(-11)	3.1(-11)
5	-	12	5.3(-13)	3.3(-12)	7.9(-12)	1.1(-11)	1.2(-11)	1.4(-11)
6	-	0	3.9(-12)	4.0(-12)	4.5(-12)	5.0(-12)	5.4(-12)	5.6(-12)
6	-	1	7.1(-12)	7.0(-12)	7.2(-12)	7.4(-12)	7.5(-12)	7.7(-12)
6	-	2	3.8(-11)	3.7(-11)	3.7(-11)	3.7(-11)	3.7(-11)	3.7(-11)
6	-	3	2.4(-11)	2.5(-11)	2.9(-11)	3.1(-11)	3.1(-11)	3.1(-11)
6	-	4	1.3(-10)	1.2(-10)	1.2(-10)	1.2(-10)	1.2(-10)	1.2(-10)
6	-	5	7.3(-11)	7.2(-11)	7.6(-11)	7.7(-11)	7.7(-11)	7.6(-11)
6	-	7	5.8(-11)	7.4(-11)	8.5(-11)	8.9(-11)	9.0(-11)	8.9(-11)
6	-	8	7.1(-11)	1.1(-10)	1.3(-10)	1.4(-10)	1.4(-10)	1.4(-10)
6	-	9	9.3(-12)	2.2(-11)	3.7(-11)	4.4(-11)	4.8(-11)	4.9(-11)
6	-	10	1.0(-11)	3.0(-11)	4.8(-11)	5.6(-11)	6.0(-11)	6.2(-11)
6	-	11	1.8(-12)	7.1(-12)	1.4(-11)	1.8(-11)	2.0(-11)	2.2(-11)
6	-	12	1.1(-12)	6.2(-12)	1.5(-11)	2.1(-11)	2.5(-11)	2.9(-11)
7	-	0	1.5(-12)	1.3(-12)	1.2(-12)	1.1(-12)	1.2(-12)	1.2(-12)
7	-	1	9.3(-12)	9.2(-12)	9.7(-12)	1.1(-11)	1.1(-11)	1.2(-11)
7	-	2	8.9(-12)	9.1(-12)	9.4(-12)	9.5(-12)	9.7(-12)	9.8(-12)
7	-	3	4.3(-11)	4.2(-11)	4.1(-11)	4.1(-11)	4.1(-11)	4.1(-11)
7	-	4	2.8(-11)	3.0(-11)	3.4(-11)	3.5(-11)	3.5(-11)	3.5(-11)
7	-	5	1.3(-10)	1.2(-10)	1.2(-10)	1.2(-10)	1.2(-10)	1.2(-10)
7	-	6	7.6(-11)	7.8(-11)	8.2(-11)	8.3(-11)	8.2(-11)	8.1(-11)
7	-	8	4.8(-11)	6.5(-11)	8.0(-11)	8.6(-11)	8.7(-11)	8.7(-11)
7	-	9	5.8(-11)	9.7(-11)	1.2(-10)	1.3(-10)	1.4(-10)	1.4(-10)
7	-	10	8.8(-12)	2.1(-11)	3.4(-11)	4.1(-11)	4.4(-11)	4.6(-11)
7	-	11	8.1(-12)	2.6(-11)	4.4(-11)	5.2(-11)	5.7(-11)	5.9(-11)
7	-	12	1.2(-12)	5.5(-12)	1.2(-11)	1.6(-11)	1.8(-11)	2.0(-11)

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TABLE 7—*Continued*

INITIAL	-	FINAL	10.0 K	20.0 K	40.0 K	60.0 K	80.0 K	100.0 K
8	-	0	1.6(-12)	1.7(-12)	1.8(-12)	2.0(-12)	2.2(-12)	2.4(-12)
8	-	1	4.0(-12)	3.6(-12)	3.2(-12)	3.0(-12)	3.0(-12)	3.0(-12)
8	-	2	1.1(-11)	1.2(-11)	1.2(-11)	1.3(-11)	1.4(-11)	1.5(-11)
8	-	3	1.2(-11)	1.3(-11)	1.3(-11)	1.4(-11)	1.4(-11)	1.4(-11)
8	-	4	4.4(-11)	4.5(-11)	4.4(-11)	4.4(-11)	4.3(-11)	4.3(-11)
8	-	5	3.0(-11)	3.2(-11)	3.6(-11)	3.8(-11)	3.8(-11)	3.8(-11)
8	-	6	1.3(-10)	1.3(-10)	1.2(-10)	1.2(-10)	1.2(-10)	1.2(-10)
8	-	7	6.7(-11)	7.3(-11)	8.0(-11)	8.2(-11)	8.1(-11)	8.0(-11)
8	-	9	4.5(-11)	6.3(-11)	7.9(-11)	8.4(-11)	8.6(-11)	8.5(-11)
8	-	10	5.2(-11)	9.3(-11)	1.2(-10)	1.3(-10)	1.4(-10)	1.4(-10)
8	-	11	6.4(-12)	1.7(-11)	3.1(-11)	3.8(-11)	4.1(-11)	4.3(-11)
8	-	12	6.0(-12)	2.2(-11)	4.1(-11)	4.9(-11)	5.4(-11)	5.6(-11)
9	-	0	1.1(-12)	1.0(-12)	9.0(-13)	8.4(-13)	8.1(-13)	7.9(-13)
9	-	1	4.7(-12)	4.4(-12)	4.2(-12)	4.4(-12)	4.8(-12)	5.2(-12)
9	-	2	7.3(-12)	7.0(-12)	6.4(-12)	6.1(-12)	6.0(-12)	5.9(-12)
9	-	3	1.4(-11)	1.3(-11)	1.4(-11)	1.5(-11)	1.6(-11)	1.6(-11)
9	-	4	1.4(-11)	1.5(-11)	1.6(-11)	1.6(-11)	1.6(-11)	1.6(-11)
9	-	5	4.8(-11)	4.9(-11)	4.7(-11)	4.6(-11)	4.6(-11)	4.5(-11)
9	-	6	2.6(-11)	3.0(-11)	3.6(-11)	3.8(-11)	3.9(-11)	3.9(-11)
9	-	7	1.2(-10)	1.3(-10)	1.2(-10)	1.2(-10)	1.2(-10)	1.2(-10)
9	-	8	6.8(-11)	7.3(-11)	8.0(-11)	8.2(-11)	8.2(-11)	8.1(-11)
9	-	10	4.2(-11)	6.1(-11)	7.7(-11)	8.3(-11)	8.4(-11)	8.4(-11)
9	-	11	4.4(-11)	8.4(-11)	1.1(-10)	1.2(-10)	1.3(-10)	1.3(-10)
9	-	12	5.9(-12)	1.6(-11)	3.0(-11)	3.6(-11)	4.0(-11)	4.2(-11)
10	-	0	1.0(-12)	1.0(-12)	9.5(-13)	9.7(-13)	1.0(-12)	1.1(-12)
10	-	1	4.0(-12)	3.8(-12)	3.6(-12)	3.5(-12)	3.4(-12)	3.3(-12)
10	-	2	5.1(-12)	5.0(-12)	5.0(-12)	5.3(-12)	5.7(-12)	6.2(-12)
10	-	3	9.1(-12)	9.2(-12)	8.8(-12)	8.6(-12)	8.5(-12)	8.5(-12)
10	-	4	1.4(-11)	1.5(-11)	1.6(-11)	1.7(-11)	1.7(-11)	1.8(-11)
10	-	5	1.5(-11)	1.6(-11)	1.6(-11)	1.7(-11)	1.7(-11)	1.7(-11)
10	-	6	4.7(-11)	5.0(-11)	4.9(-11)	4.8(-11)	4.8(-11)	4.7(-11)
10	-	7	3.0(-11)	3.2(-11)	3.6(-11)	3.8(-11)	3.8(-11)	3.8(-11)
10	-	8	1.3(-10)	1.3(-10)	1.3(-10)	1.3(-10)	1.3(-10)	1.2(-10)
10	-	9	6.8(-11)	7.4(-11)	8.1(-11)	8.2(-11)	8.2(-11)	8.0(-11)
10	-	11	4.0(-11)	6.0(-11)	7.8(-11)	8.4(-11)	8.5(-11)	8.5(-11)
10	-	12	3.9(-11)	7.8(-11)	1.1(-10)	1.2(-10)	1.3(-10)	1.3(-10)
11	-	0	1.7(-12)	1.7(-12)	1.6(-12)	1.5(-12)	1.5(-12)	1.4(-12)
11	-	1	2.2(-12)	2.2(-12)	2.0(-12)	2.0(-12)	2.1(-12)	2.2(-12)
11	-	2	6.5(-12)	6.7(-12)	6.4(-12)	6.2(-12)	6.0(-12)	5.9(-12)
11	-	3	6.5(-12)	6.4(-12)	6.3(-12)	6.6(-12)	7.0(-12)	7.5(-12)
11	-	4	9.5(-12)	9.8(-12)	9.3(-12)	9.1(-12)	9.1(-12)	9.2(-12)
11	-	5	1.6(-11)	1.6(-11)	1.7(-11)	1.8(-11)	1.9(-11)	2.0(-11)
11	-	6	1.4(-11)	1.5(-11)	1.5(-11)	1.6(-11)	1.6(-11)	1.6(-11)
11	-	7	4.9(-11)	5.1(-11)	5.0(-11)	4.9(-11)	4.9(-11)	4.8(-11)
11	-	8	2.7(-11)	3.1(-11)	3.5(-11)	3.7(-11)	3.8(-11)	3.8(-11)
11	-	9	1.2(-10)	1.3(-10)	1.3(-10)	1.3(-10)	1.2(-10)	1.2(-10)
11	-	10	6.9(-11)	7.5(-11)	8.3(-11)	8.5(-11)	8.4(-11)	8.3(-11)
11	-	12	3.5(-11)	5.8(-11)	7.7(-11)	8.4(-11)	8.6(-11)	8.6(-11)

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TABLE 7—*Continued*

INITIAL	-	FINAL	10.0 K	20.0 K	40.0 K	60.0 K	80.0 K	100.0 K
12	-	0	6.1(-13)	5.1(-13)	4.1(-13)	3.9(-13)	4.0(-13)	4.2(-13)
12	-	1	4.3(-12)	4.5(-12)	4.4(-12)	4.3(-12)	4.2(-12)	4.1(-12)
12	-	2	3.7(-12)	3.5(-12)	3.2(-12)	3.1(-12)	3.1(-12)	3.2(-12)
12	-	3	7.4(-12)	7.4(-12)	7.0(-12)	6.9(-12)	6.8(-12)	6.8(-12)
12	-	4	7.6(-12)	7.7(-12)	7.7(-12)	8.1(-12)	8.6(-12)	9.1(-12)
12	-	5	9.3(-12)	9.2(-12)	8.7(-12)	8.5(-12)	8.6(-12)	8.7(-12)
12	-	6	1.6(-11)	1.7(-11)	1.8(-11)	1.9(-11)	2.0(-11)	2.1(-11)
12	-	7	1.4(-11)	1.4(-11)	1.5(-11)	1.5(-11)	1.6(-11)	1.6(-11)
12	-	8	4.8(-11)	5.1(-11)	5.1(-11)	5.0(-11)	5.0(-11)	4.9(-11)
12	-	9	3.1(-11)	3.3(-11)	3.6(-11)	3.8(-11)	3.9(-11)	3.9(-11)
12	-	10	1.3(-10)	1.3(-10)	1.3(-10)	1.3(-10)	1.2(-10)	1.2(-10)
12	-	11	6.6(-11)	7.5(-11)	8.5(-11)	8.7(-11)	8.6(-11)	8.5(-11)

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TABLE 8

COLLISION RATE CONSTANTS (in units of $cm^3 s^{-1}$) AS A FUNCTION OF KINETIC TEMPERATURE HC_3N–He

INITIAL	-	FINAL	10.0 K	20.0 K	40.0 K	80.0 K
0	-	1	1.1(-10)	1.3(-10)	1.2(-10)	1.4(-10)
0	-	2	5.5(-11)	5.9(-11)	6.0(-11)	7.3(-11)
0	-	3	3.8(-11)	4.3(-11)	4.5(-11)	6.1(-11)
0	-	4	3.2(-11)	3.9(-11)	4.4(-11)	5.3(-11)
0	-	5	1.8(-11)	3.3(-11)	3.9(-11)	3.4(-11)
0	-	6	1.2(-11)	2.0(-11)	3.4(-11)	4.2(-11)
0	-	7	6.2(-12)	2.0(-11)	3.7(-11)	4.7(-11)
0	-	8	1.7(-12)	9.9(-12)	1.8(-11)	3.0(-11)
0	-	9	6.0(-13)	6.7(-12)	1.7(-11)	2.7(-11)
0	-	10	4.0(-13)	1.7(-12)	1.2(-11)	1.6(-11)
0	-	11	0.0(0)	1.0(-12)	7.8(-12)	1.6(-11)
0	-	12	0.0(0)	6.8(-13)	3.8(-12)	1.4(-11)
0	-	13	0.0(0)	1.0(-13)	2.4(-12)	1.1(-11)
0	-	14	0.0(0)	1.0(-13)	1.7(-12)	9.2(-12)
0	-	15	0.0(0)	0.0(0)	1.0(-12)	7.5(-12)
0	-	16	0.0(0)	0.0(0)	2.0(-13)	3.5(-12)
0	-	17	0.0(0)	0.0(0)	3.0(-13)	2.9(-12)
0	-	18	0.0(0)	0.0(0)	0.0(0)	2.6(-12)
0	-	19	0.0(0)	0.0(0)	2.0(-13)	2.4(-12)
0	-	20	0.0(0)	0.0(0)	0.0(0)	3.0(-13)
0	-	21	0.0(0)	0.0(0)	0.0(0)	6.0(-13)
0	-	22	0.0(0)	0.0(0)	0.0(0)	6.0(-13)
0	-	23	0.0(0)	0.0(0)	0.0(0)	0.0(0)
1	-	0	3.7(-11)	4.3(-11)	4.2(-11)	4.9(-11)
1	-	2	1.1(-10)	1.1(-10)	1.2(-10)	1.4(-10)
1	-	3	5.7(-11)	5.5(-11)	7.2(-11)	7.8(-11)
1	-	4	3.9(-11)	4.5(-11)	5.5(-11)	6.6(-11)
1	-	5	2.5(-11)	3.7(-11)	4.9(-11)	5.6(-11)
1	-	6	1.3(-11)	2.9(-11)	4.0(-11)	5.2(-11)
1	-	7	7.0(-12)	1.8(-11)	3.0(-11)	4.0(-11)
1	-	8	2.6(-12)	1.1(-11)	2.7(-11)	3.3(-11)
1	-	9	1.1(-12)	5.9(-12)	1.8(-11)	2.6(-11)
1	-	10	5.0(-13)	3.5(-12)	1.2(-11)	2.0(-11)
1	-	11	1.7(-13)	1.6(-12)	8.6(-12)	1.3(-11)
1	-	12	0.0(0)	3.1(-13)	5.7(-12)	1.5(-11)
1	-	13	0.0(0)	5.0(-13)	2.7(-12)	7.2(-12)
1	-	14	0.0(0)	0.0(0)	1.4(-12)	7.0(-12)
1	-	15	0.0(0)	0.0(0)	1.1(-12)	5.2(-12)
1	-	16	0.0(0)	0.0(0)	9.0(-13)	4.2(-12)
1	-	17	0.0(0)	0.0(0)	3.0(-13)	2.5(-12)
1	-	18	0.0(0)	0.0(0)	2.5(-13)	1.3(-12)
1	-	19	0.0(0)	0.0(0)	1.0(-13)	1.3(-12)
1	-	20	0.0(0)	0.0(0)	1.0(-13)	5.0(-13)
1	-	21	0.0(0)	0.0(0)	0.0(0)	1.1(-12)
1	-	22	0.0(0)	0.0(0)	0.0(0)	2.0(-13)
1	-	23	0.0(0)	0.0(0)	0.0(0)	2.9(-13)

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TABLE 8—*Continued*

INITIAL	-	FINAL	10.0 K	20.0 K	40.0 K	80.0 K
2	-	0	1.3(-11)	1.3(-11)	1.3(-11)	1.5(-11)
2	-	1	6.9(-11)	7.0(-11)	7.5(-11)	8.6(-11)
2	-	3	9.3(-11)	1.1(-10)	1.2(-10)	1.3(-10)
2	-	4	4.6(-11)	5.2(-11)	6.8(-11)	7.5(-11)
2	-	5	3.0(-11)	3.9(-11)	4.9(-11)	6.2(-11)
2	-	6	1.5(-11)	3.0(-11)	4.2(-11)	5.2(-11)
2	-	7	9.9(-12)	2.2(-11)	3.6(-11)	3.9(-11)
2	-	8	5.0(-12)	1.4(-11)	2.2(-11)	4.0(-11)
2	-	9	2.5(-12)	9.5(-12)	2.2(-11)	3.1(-11)
2	-	10	5.7(-13)	4.5(-12)	1.3(-11)	2.4(-11)
2	-	11	3.0(-13)	2.6(-12)	8.8(-12)	2.0(-11)
2	-	12	0.0(0)	9.9(-13)	6.0(-12)	1.4(-11)
2	-	13	0.0(0)	3.0(-13)	4.4(-12)	1.1(-11)
2	-	14	0.0(0)	3.0(-13)	1.9(-12)	8.6(-12)
2	-	15	0.0(0)	1.5(-13)	1.7(-12)	8.7(-12)
2	-	16	0.0(0)	0.0(0)	5.0(-13)	5.9(-12)
2	-	17	0.0(0)	0.0(0)	4.0(-13)	5.4(-12)
2	-	18	0.0(0)	2.0(-13)	0.0(0)	1.7(-12)
2	-	19	0.0(0)	0.0(0)	2.0(-13)	2.5(-12)
2	-	20	0.0(0)	0.0(0)	2.0(-13)	1.0(-12)
2	-	21	0.0(0)	0.0(0)	0.0(0)	1.2(-12)
2	-	22	0.0(0)	0.0(0)	0.0(0)	6.0(-13)
2	-	23	0.0(0)	0.0(0)	0.0(0)	4.0(-13)
3	-	0	7.0(-12)	7.0(-12)	6.9(-12)	9.0(-12)
3	-	1	3.0(-11)	2.6(-11)	3.2(-11)	3.4(-11)
3	-	2	7.6(-11)	8.5(-11)	8.6(-11)	9.4(-11)
3	-	4	7.9(-11)	1.0(-10)	1.1(-10)	1.3(-10)
3	-	5	4.1(-11)	5.1(-11)	6.0(-11)	7.7(-11)
3	-	6	2.4(-11)	3.7(-11)	4.6(-11)	5.2(-11)
3	-	7	1.6(-11)	2.4(-11)	3.5(-11)	3.5(-11)
3	-	8	6.7(-12)	1.6(-11)	2.8(-11)	4.4(-11)
3	-	9	3.5(-12)	1.3(-11)	2.1(-11)	3.3(-11)
3	-	10	1.4(-12)	5.4(-12)	1.7(-11)	2.8(-11)
3	-	11	4.0(-13)	3.7(-12)	1.2(-11)	1.9(-11)
3	-	12	2.2(-13)	1.2(-11)	8.5(-12)	1.7(-11)
3	-	13	0.0(0)	6.0(-13)	4.7(-12)	1.3(-11)
3	-	14	0.0(0)	1.0(-13)	3.0(-12)	1.0(-11)
3	-	15	0.0(0)	2.7(-13)	2.0(-12)	5.2(-12)
3	-	16	0.0(0)	0.0(0)	9.0(-13)	7.0(-12)
3	-	17	0.0(0)	0.0(0)	1.0(-12)	3.4(-12)
3	-	18	0.0(0)	0.0(0)	2.0(-13)	1.9(-12)
3	-	19	0.0(0)	0.0(0)	1.0(-13)	3.3(-12)
3	-	20	0.0(0)	0.0(0)	1.2(-13)	2.5(-12)
3	-	21	0.0(0)	0.0(0)	1.0(-13)	7.0(-13)
3	-	22	0.0(0)	0.0(0)	0.0(0)	7.0(-13)
3	-	23	0.0(0)	0.0(0)	0.0(0)	4.0(-13)

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TABLE 8—*Continued*

INITIAL	-	FINAL	10.0 K	20.0 K	40.0 K	80.0 K
4	-	0	5.5(-12)	5.3(-12)	5.4(-12)	6.3(-12)
4	-	1	1.9(-11)	1.8(-11)	2.0(-11)	2.3(-11)
4	-	2	3.4(-11)	3.4(-11)	4.1(-11)	4.4(-11)
4	-	3	7.3(-11)	8.6(-11)	9.1(-11)	1.0(-10)
4	-	5	7.4(-11)	9.5(-11)	1.1(-10)	1.2(-10)
4	-	6	3.5(-11)	4.4(-11)	5.8(-11)	7.1(-11)
4	-	7	1.7(-11)	3.1(-11)	4.5(-11)	5.4(-11)
4	-	8	1.1(-11)	2.2(-11)	3.4(-11)	4.1(-11)
4	-	9	7.0(-12)	1.6(-11)	2.4(-11)	3.9(-11)
4	-	10	2.5(-12)	9.8(-12)	1.8(-11)	3.0(-11)
4	-	11	1.0(-12)	4.0(-12)	1.5(-11)	2.3(-11)
4	-	12	4.4(-13)	2.6(-12)	9.5(-12)	2.2(-11)
4	-	13	3.0(-13)	9.0(-13)	6.4(-12)	1.6(-11)
4	-	14	0.0(0)	6.0(-13)	4.1(-12)	1.1(-11)
4	-	15	0.0(0)	3.2(-13)	2.3(-12)	5.2(-12)
4	-	16	0.0(0)	2.0(-13)	1.7(-12)	6.9(-12)
4	-	17	0.0(0)	0.0(0)	1.2(-12)	4.8(-12)
4	-	18	0.0(0)	0.0(0)	5.0(-13)	3.4(-12)
4	-	19	0.0(0)	0.0(0)	2.0(-13)	2.9(-12)
4	-	20	0.0(0)	0.0(0)	1.0(-13)	2.5(-12)
4	-	21	0.0(0)	0.0(0)	1.0(-13)	2.0(-12)
4	-	22	0.0(0)	0.0(0)	0.0(0)	1.0(-12)
4	-	23	0.0(0)	0.0(0)	0.0(0)	1.4(-12)
5	-	0	3.1(-12)	4.1(-12)	4.1(-12)	3.3(-12)
5	-	1	1.3(-11)	1.4(-11)	1.5(-11)	1.6(-11)
5	-	2	2.3(-11)	2.3(-11)	2.5(-11)	3.0(-11)
5	-	3	3.8(-11)	4.0(-11)	4.2(-11)	5.1(-11)
5	-	4	7.5(-11)	8.6(-11)	9.4(-11)	1.0(-10)
5	-	6	6.5(-11)	8.9(-11)	1.0(-10)	1.2(-10)
5	-	7	3.4(-11)	4.3(-11)	5.2(-11)	6.8(-11)
5	-	8	1.5(-11)	2.8(-11)	4.1(-11)	4.7(-11)
5	-	9	8.1(-12)	1.7(-11)	2.7(-11)	4.3(-11)
5	-	10	4.2(-12)	1.3(-11)	2.3(-11)	3.8(-11)
5	-	11	2.0(-12)	7.3(-12)	1.6(-11)	2.7(-11)
5	-	12	8.9(-13)	4.3(-12)	1.2(-11)	2.2(-11)
5	-	13	2.0(-13)	1.5(-12)	9.4(-12)	1.9(-11)
5	-	14	1.0(-13)	1.0(-12)	5.2(-12)	1.3(-11)
5	-	15	0.0(0)	6.7(-13)	3.3(-12)	1.0(-11)
5	-	16	0.0(0)	4.0(-13)	1.8(-12)	7.2(-12)
5	-	17	0.0(0)	1.0(-13)	9.0(-13)	5.1(-12)
5	-	18	0.0(0)	0.0(0)	4.0(-13)	3.4(-12)
5	-	19	0.0(0)	0.0(0)	5.0(-13)	4.6(-12)
5	-	20	0.0(0)	0.0(0)	2.0(-13)	2.7(-12)
5	-	21	0.0(0)	0.0(0)	4.0(-13)	2.6(-12)
5	-	22	0.0(0)	0.0(0)	0.0(0)	1.6(-12)
5	-	23	0.0(0)	0.0(0)	0.0(0)	9.0(-13)

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TABLE 8—*Continued*

INITIAL	-	FINAL	10.0 K	20.0 K	40.0 K	80.0 K
6	-	0	2.3(-12)	2.5(-12)	3.2(-12)	3.6(-12)
6	-	1	7.2(-12)	1.0(-11)	1.1(-11)	1.3(-11)
6	-	2	1.3(-11)	1.7(-11)	2.0(-11)	2.2(-11)
6	-	3	2.5(-11)	2.8(-11)	2.9(-11)	3.0(-11)
6	-	4	3.9(-11)	3.9(-11)	4.5(-11)	5.2(-11)
6	-	5	7.1(-11)	8.6(-11)	9.2(-11)	1.0(-10)
6	-	7	6.5(-11)	8.3(-11)	9.7(-11)	1.2(-10)
6	-	8	2.8(-11)	3.6(-11)	5.2(-11)	6.0(-11)
6	-	9	1.3(-11)	2.9(-11)	3.3(-11)	5.4(-11)
6	-	10	6.9(-12)	1.6(-11)	2.6(-11)	3.8(-11)
6	-	11	3.7(-12)	1.0(-11)	2.1(-11)	3.1(-11)
6	-	12	1.4(-12)	6.5(-12)	1.6(-11)	2.5(-11)
6	-	13	6.0(-13)	3.2(-12)	1.1(-11)	2.1(-11)
6	-	14	3.2(-13)	1.0(-12)	7.2(-12)	1.9(-11)
6	-	15	0.0(0)	1.3(-12)	4.1(-12)	1.3(-11)
6	-	16	0.0(0)	2.0(-13)	3.1(-12)	8.6(-12)
6	-	17	0.0(0)	1.0(-13)	1.9(-12)	6.2(-12)
6	-	18	0.0(0)	2.0(-13)	7.0(-13)	5.1(-12)
6	-	19	0.0(0)	0.0(0)	4.0(-13)	4.6(-12)
6	-	20	0.0(0)	0.0(0)	8.0(-13)	3.4(-12)
6	-	21	0.0(0)	0.0(0)	3.0(-13)	2.3(-12)
6	-	22	0.0(0)	0.0(0)	0.0(0)	2.5(-12)
6	-	23	0.0(0)	0.0(0)	0.0(0)	2.2(-12)
7	-	0	1.4(-12)	2.4(-12)	3.3(-12)	3.6(-12)
7	-	1	4.6(-12)	6.6(-12)	7.9(-12)	9.3(-12)
7	-	2	9.8(-12)	1.3(-11)	1.6(-11)	1.5(-11)
7	-	3	1.9(-11)	1.8(-11)	2.1(-11)	1.9(-11)
7	-	4	2.3(-11)	2.7(-11)	3.3(-11)	3.6(-11)
7	-	5	4.4(-11)	4.1(-11)	4.4(-11)	5.4(-11)
7	-	6	7.7(-11)	8.4(-11)	9.1(-11)	1.1(-10)
7	-	8	6.3(-11)	7.8(-11)	1.0(-10)	1.2(-10)
7	-	9	2.5(-11)	3.3(-11)	4.0(-11)	5.2(-11)
7	-	10	1.2(-11)	2.4(-11)	3.4(-11)	4.6(-11)
7	-	11	8.6(-12)	1.4(-11)	2.2(-11)	3.2(-11)
7	-	12	2.8(-12)	8.7(-12)	2.0(-11)	2.8(-11)
7	-	13	2.3(-12)	5.7(-12)	1.3(-11)	2.0(-11)
7	-	14	1.1(-12)	4.7(-12)	1.2(-11)	2.0(-11)
7	-	15	2.2(-13)	1.5(-12)	7.6(-12)	1.8(-11)
7	-	16	0.0(0)	1.3(-12)	4.8(-12)	1.1(-11)
7	-	17	0.0(0)	3.6(-13)	3.0(-12)	7.0(-12)
7	-	18	0.0(0)	1.7(-13)	1.9(-12)	6.2(-12)
7	-	19	0.0(0)	1.1(-13)	8.9(-13)	4.7(-12)
7	-	20	0.0(0)	0.0(0)	5.7(-13)	3.7(-12)
7	-	21	0.0(0)	0.0(0)	3.1(-13)	2.6(-12)
7	-	22	0.0(0)	0.0(0)	2.1(-13)	2.1(-12)
7	-	23	0.0(0)	0.0(0)	0.0(0)	1.0(-12)

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TABLE 8—*Continued*

INITIAL	-	FINAL	10.0 K	20.0 K	40.0 K	80.0 K
8	-	0	4.7(-13)	1.3(-12)	1.6(-12)	2.1(-12)
8	-	1	2.2(-12)	4.3(-12)	6.9(-12)	7.0(-12)
8	-	2	6.2(-12)	8.3(-12)	9.4(-12)	1.4(-11)
8	-	3	1.0(-11)	1.3(-11)	1.6(-11)	2.1(-11)
8	-	4	1.7(-11)	2.1(-11)	2.4(-11)	2.5(-11)
8	-	5	2.4(-11)	2.9(-11)	3.3(-11)	3.4(-11)
8	-	6	4.1(-11)	3.8(-11)	4.7(-11)	5.0(-11)
8	-	7	7.9(-11)	8.2(-11)	9.6(-11)	1.1(-10)
8	-	9	5.6(-11)	8.1(-11)	8.5(-11)	1.2(-10)
8	-	10	2.2(-11)	3.7(-11)	4.6(-11)	5.9(-11)
8	-	11	1.1(-11)	2.0(-11)	3.0(-11)	4.0(-11)
8	-	12	4.4(-12)	1.3(-11)	2.1(-11)	3.7(-11)
8	-	13	1.5(-12)	9.2(-12)	2.0(-11)	2.8(-11)
8	-	14	6.0(-13)	4.8(-12)	1.2(-11)	3.0(-11)
8	-	15	3.8(-13)	2.7(-12)	8.3(-12)	1.5(-11)
8	-	16	1.0(-13)	1.1(-12)	5.0(-12)	1.5(-11)
8	-	17	0.0(0)	9.0(-13)	3.7(-12)	1.1(-11)
8	-	18	0.0(0)	3.0(-13)	2.5(-12)	7.1(-12)
8	-	19	0.0(0)	1.6(-13)	1.7(-12)	4.4(-12)
8	-	20	0.0(0)	1.0(-13)	9.0(-13)	3.8(-12)
8	-	21	0.0(0)	0.0(0)	4.0(-13)	4.6(-12)
8	-	22	0.0(0)	0.0(0)	2.9(-13)	3.1(-12)
8	-	23	0.0(0)	0.0(0)	1.9(-13)	2.8(-12)
9	-	0	2.3(-13)	9.4(-13)	1.4(-12)	1.8(-12)
9	-	1	1.2(-12)	2.4(-12)	4.5(-12)	5.3(-12)
9	-	2	4.1(-12)	6.3(-12)	9.3(-12)	1.0(-11)
9	-	3	7.1(-12)	1.1(-11)	1.2(-11)	1.5(-11)
9	-	4	1.5(-11)	1.6(-11)	1.6(-11)	2.2(-11)
9	-	5	1.7(-11)	1.9(-11)	2.1(-11)	2.9(-11)
9	-	6	2.5(-11)	3.3(-11)	3.0(-11)	4.2(-11)
9	-	7	4.2(-11)	3.7(-11)	3.8(-11)	4.5(-11)
9	-	8	7.4(-11)	8.8(-11)	8.4(-11)	1.1(-10)
9	-	10	5.0(-11)	6.8(-11)	8.6(-11)	1.1(-10)
9	-	11	2.3(-11)	3.0(-11)	3.8(-11)	5.0(-11)
9	-	12	8.8(-12)	1.9(-11)	3.4(-11)	4.1(-11)
9	-	13	7.7(-12)	1.3(-11)	2.0(-11)	2.9(-11)
9	-	14	3.7(-12)	9.7(-12)	1.7(-11)	2.1(-11)
9	-	15	7.0(-13)	3.5(-12)	1.1(-11)	1.8(-11)
9	-	16	9.6(-13)	4.1(-12)	1.0(-11)	1.8(-11)
9	-	17	2.6(-13)	1.8(-12)	5.3(-12)	1.1(-11)
9	-	18	0.0(0)	1.1(-12)	4.1(-12)	9.5(-12)
9	-	19	0.0(0)	3.1(-13)	2.6(-12)	6.1(-12)
9	-	20	0.0(0)	1.5(-13)	1.6(-12)	5.4(-12)
9	-	21	0.0(0)	0.0(0)	7.7(-13)	4.1(-12)
9	-	22	0.0(0)	0.0(0)	4.9(-13)	3.2(-12)
9	-	23	0.0(0)	0.0(0)	2.7(-13)	2.2(-12)

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TABLE 8—*Continued*

INITIAL	-	FINAL	10.0 K	20.0 K	40.0 K	80.0 K
10	-	0	2.1(-13)	2.7(-13)	1.0(-12)	1.0(-12)
10	-	1	7.5(-13)	1.6(-12)	3.1(-12)	3.8(-12)
10	-	2	1.3(-12)	3.3(-12)	5.7(-12)	7.4(-12)
10	-	3	3.9(-12)	5.3(-12)	9.9(-12)	1.2(-11)
10	-	4	7.7(-12)	1.1(-11)	1.3(-11)	1.6(-11)
10	-	5	1.3(-11)	1.6(-11)	1.9(-11)	2.5(-11)
10	-	6	1.9(-11)	2.0(-11)	2.3(-11)	2.8(-11)
10	-	7	2.7(-11)	3.0(-11)	3.2(-11)	3.8(-11)
10	-	8	4.0(-11)	4.5(-11)	4.6(-11)	5.3(-11)
10	-	9	7.0(-11)	7.7(-11)	8.7(-11)	1.1(-10)
10	-	11	4.3(-11)	6.6(-11)	8.1(-11)	1.1(-10)
10	-	12	2.1(-11)	3.1(-11)	4.3(-11)	5.6(-11)
10	-	13	8.2(-12)	1.7(-11)	2.8(-11)	3.6(-11)
10	-	14	3.4(-12)	1.1(-11)	2.1(-11)	3.3(-11)
10	-	15	1.6(-12)	7.4(-12)	1.7(-11)	2.7(-11)
10	-	16	6.0(-13)	5.1(-12)	1.1(-11)	2.0(-11)
10	-	17	3.0(-13)	2.0(-12)	9.4(-12)	1.3(-11)
10	-	18	2.5(-13)	1.5(-12)	5.2(-12)	1.3(-11)
10	-	19	0.0(0)	8.0(-13)	3.8(-12)	8.5(-12)
10	-	20	0.0(0)	2.0(-13)	2.2(-12)	8.0(-12)
10	-	21	0.0(0)	1.0(-13)	2.3(-12)	4.6(-12)
10	-	22	0.0(0)	0.0(0)	6.0(-13)	3.8(-12)
10	-	23	0.0(0)	0.0(0)	7.0(-13)	4.1(-12)
11	-	0	0.0(0)	1.8(-13)	7.0(-13)	1.0(-12)
11	-	1	3.8(-13)	8.6(-13)	2.3(-12)	2.5(-12)
11	-	2	1.0(-12)	2.2(-12)	3.8(-12)	6.2(-12)
11	-	3	1.7(-12)	4.2(-12)	7.1(-12)	8.2(-12)
11	-	4	4.5(-12)	5.3(-12)	1.1(-11)	1.2(-11)
11	-	5	8.9(-12)	1.1(-11)	1.4(-11)	1.7(-11)
11	-	6	1.5(-11)	1.6(-11)	2.0(-11)	2.2(-11)
11	-	7	3.0(-11)	2.1(-11)	2.2(-11)	2.5(-11)
11	-	8	3.1(-11)	2.9(-11)	3.1(-11)	3.5(-11)
11	-	9	4.7(-11)	4.0(-11)	3.9(-11)	4.6(-11)
11	-	10	6.3(-11)	7.6(-11)	8.3(-11)	1.0(-10)
11	-	12	3.9(-11)	6.3(-11)	8.5(-11)	1.1(-10)
11	-	13	2.1(-11)	2.9(-11)	3.6(-11)	4.8(-11)
11	-	14	1.1(-11)	1.8(-11)	2.5(-11)	3.5(-11)
11	-	15	3.2(-12)	1.0(-11)	2.6(-11)	2.7(-11)
11	-	16	3.4(-12)	8.8(-12)	1.5(-11)	2.0(-11)
11	-	17	1.9(-12)	4.6(-12)	1.0(-11)	1.7(-11)
11	-	18	9.0(-13)	3.7(-12)	9.5(-12)	1.6(-11)
11	-	19	2.5(-13)	1.6(-12)	4.8(-12)	1.0(-11)
11	-	20	0.0(0)	1.0(-12)	3.7(-12)	8.6(-12)
11	-	21	0.0(0)	2.8(-13)	2.3(-12)	5.5(-12)
11	-	22	0.0(0)	1.3(-13)	1.5(-12)	4.9(-12)
11	-	23	0.0(0)	0.0(0)	6.8(-13)	3.7(-12)

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TABLE 8—*Continued*

INITIAL	-	FINAL	10.0 K	20.0 K	40.0 K	80.0 K
12	-	0	0.0(0)	1.5(-13)	3.6(-13)	8.6(-13)
12	-	1	2.0(-13)	2.0(-13)	1.6(-12)	2.8(-12)
12	-	2	2.0(-13)	1.0(-12)	2.7(-12)	4.4(-12)
12	-	3	1.4(-12)	1.6(-11)	5.2(-12)	7.1(-12)
12	-	4	3.1(-12)	4.2(-12)	7.2(-12)	1.1(-11)
12	-	5	6.1(-12)	7.5(-12)	1.0(-11)	1.3(-11)
12	-	6	9.0(-12)	1.2(-11)	1.5(-11)	1.8(-11)
12	-	7	1.5(-11)	1.5(-11)	2.0(-11)	2.2(-11)
12	-	8	1.9(-11)	2.2(-11)	2.3(-11)	3.2(-11)
12	-	9	2.8(-11)	2.9(-11)	3.7(-11)	3.7(-11)
12	-	10	4.7(-11)	4.2(-11)	4.6(-11)	5.3(-11)
12	-	11	6.1(-11)	7.6(-11)	9.0(-11)	1.1(-10)
12	-	13	3.9(-11)	6.0(-11)	7.6(-11)	1.0(-10)
12	-	14	1.6(-11)	2.5(-11)	3.6(-11)	5.1(-11)
12	-	15	7.4(-12)	1.5(-11)	2.4(-11)	3.8(-11)
12	-	16	2.3(-12)	1.0(-11)	1.9(-11)	3.1(-11)
12	-	17	1.0(-12)	6.8(-12)	1.3(-11)	2.2(-11)
12	-	18	1.0(-13)	4.2(-12)	1.2(-11)	2.2(-11)
12	-	19	1.0(-13)	1.9(-12)	8.7(-12)	1.5(-11)
12	-	20	2.4(-13)	7.0(-13)	4.2(-12)	1.1(-11)
12	-	21	0.0(0)	5.0(-13)	4.0(-12)	1.0(-11)
12	-	22	0.0(0)	2.0(-13)	2.9(-12)	6.3(-12)
12	-	23	0.0(0)	1.3(-13)	1.1(-12)	4.6(-12)
13	-	0	0.0(0)	0.0(0)	2.4(-13)	6.8(-13)
13	-	1	0.0(0)	4.0(-13)	8.0(-13)	1.3(-12)
13	-	2	0.0(0)	3.8(-13)	2.1(-12)	3.4(-12)
13	-	3	9.6(-13)	9.9(-13)	3.1(-12)	5.2(-12)
13	-	4	3.4(-12)	1.8(-12)	5.2(-12)	8.1(-12)
13	-	5	2.3(-12)	3.2(-12)	8.8(-12)	1.2(-11)
13	-	6	6.1(-12)	7.1(-12)	1.1(-11)	1.5(-11)
13	-	7	2.0(-11)	1.3(-11)	1.4(-11)	1.6(-11)
13	-	8	1.0(-11)	1.9(-11)	2.3(-11)	2.4(-11)
13	-	9	4.0(-11)	2.4(-11)	2.3(-11)	2.6(-11)
13	-	10	3.1(-11)	2.9(-11)	3.3(-11)	3.4(-11)
13	-	11	5.4(-11)	4.2(-11)	4.0(-11)	4.7(-11)
13	-	12	6.5(-11)	7.4(-11)	8.1(-11)	1.0(-10)
13	-	14	5.3(-11)	7.2(-11)	8.0(-11)	9.8(-11)
13	-	15	1.4(-11)	2.5(-11)	4.0(-11)	5.0(-11)
13	-	16	1.0(-11)	1.7(-11)	2.4(-11)	3.4(-11)
13	-	17	6.6(-12)	1.1(-11)	1.9(-11)	2.6(-11)
13	-	18	3.2(-12)	8.2(-12)	1.4(-11)	1.9(-11)
13	-	19	1.8(-12)	4.2(-12)	9.5(-12)	1.6(-11)
13	-	20	8.6(-13)	3.4(-12)	8.8(-12)	1.5(-11)
13	-	21	2.4(-13)	1.5(-12)	4.4(-12)	9.5(-12)
13	-	22	0.0(0)	9.4(-13)	3.4(-12)	8.0(-12)
13	-	23	0.0(0)	2.6(-13)	2.1(-12)	5.1(-12)

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TABLE 8—*Continued*

INITIAL	-	FINAL	10.0 K	20.0 K	40.0 K	80.0 K
14	-	0	0.0(0)	0.0(0)	1.8(-13)	5.6(-13)
14	-	1	0.0(0)	0.0(0)	4.5(-13)	1.3(-12)
14	-	2	0.0(0)	4.8(-13)	1.0(-12)	2.6(-12)
14	-	3	0.0(0)	2.1(-13)	2.1(-12)	4.2(-12)
14	-	4	1.5(-12)	1.5(-12)	3.6(-12)	5.5(-12)
14	-	5	1.9(-12)	2.7(-12)	5.3(-12)	8.4(-12)
14	-	6	5.6(-12)	2.8(-12)	8.1(-12)	1.4(-11)
14	-	7	1.6(-11)	1.3(-11)	1.4(-11)	1.6(-11)
14	-	8	7.2(-12)	1.3(-11)	1.5(-11)	2.5(-11)
14	-	9	3.3(-11)	2.3(-11)	2.1(-11)	2.0(-11)
14	-	10	2.2(-11)	2.3(-11)	2.7(-11)	3.2(-11)
14	-	11	4.7(-11)	3.3(-11)	3.0(-11)	3.4(-11)
14	-	12	4.4(-11)	3.9(-11)	4.2(-11)	5.1(-11)
14	-	13	9.1(-11)	9.1(-11)	8.6(-11)	9.8(-11)
14	-	15	3.4(-11)	5.9(-11)	7.4(-11)	1.1(-10)
14	-	16	1.9(-11)	2.7(-11)	3.4(-11)	4.6(-11)
14	-	17	9.7(-12)	1.6(-11)	2.3(-11)	3.3(-11)
14	-	18	6.4(-12)	1.1(-11)	1.7(-11)	2.5(-11)
14	-	19	3.1(-12)	7.9(-12)	1.4(-11)	1.8(-11)
14	-	20	1.7(-12)	4.1(-12)	9.2(-12)	1.6(-11)
14	-	21	8.4(-13)	3.3(-12)	8.5(-12)	1.5(-11)
14	-	22	2.3(-13)	1.5(-12)	4.2(-12)	9.2(-12)
14	-	23	0.0(0)	9.1(-13)	3.3(-12)	7.7(-12)
15	-	0	0.0(0)	0.0(0)	1.2(-13)	4.7(-13)
15	-	1	0.0(0)	0.0(0)	3.8(-13)	9.6(-13)
15	-	2	0.0(0)	3.0(-13)	1.0(-12)	2.7(-12)
15	-	3	3.0(-13)	7.4(-13)	1.5(-12)	2.2(-12)
15	-	4	3.0(-13)	1.0(-12)	2.3(-12)	2.7(-12)
15	-	5	1.0(-12)	2.4(-12)	3.7(-12)	6.4(-12)
15	-	6	1.5(-12)	4.6(-12)	5.1(-12)	9.0(-12)
15	-	7	5.8(-12)	5.4(-12)	1.0(-11)	1.4(-11)
15	-	8	8.2(-12)	9.3(-12)	1.1(-11)	1.3(-11)
15	-	9	1.1(-11)	1.1(-11)	1.6(-11)	1.7(-11)
15	-	10	1.8(-11)	2.1(-11)	2.3(-11)	2.6(-11)
15	-	11	2.5(-11)	2.4(-11)	3.5(-11)	2.7(-11)
15	-	12	3.7(-11)	3.0(-11)	3.1(-11)	3.9(-11)
15	-	13	4.3(-11)	4.1(-11)	4.8(-11)	5.1(-11)
15	-	14	6.1(-11)	7.7(-11)	8.1(-11)	1.1(-10)
15	-	16	3.2(-11)	5.4(-11)	7.5(-11)	1.1(-10)
15	-	17	9.8(-12)	2.5(-11)	3.6(-11)	4.3(-11)
15	-	18	3.5(-12)	1.5(-11)	2.1(-11)	3.4(-11)
15	-	19	1.6(-12)	8.4(-12)	1.8(-11)	2.9(-11)
15	-	20	4.0(-13)	3.4(-12)	1.1(-11)	1.5(-11)
15	-	21	2.0(-13)	3.5(-12)	9.8(-12)	1.1(-11)
15	-	22	1.0(-13)	1.3(-12)	7.8(-12)	1.4(-11)
15	-	23	2.3(-13)	6.0(-13)	5.1(-12)	8.4(-12)

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TABLE 8—*Continued*

INITIAL	-	FINAL	10.0 K	20.0 K	40.0 K	80.0 K
16	-	0	0.0(0)	0.0(0)	0.0(0)	2.2(-13)
16	-	1	0.0(0)	0.0(0)	3.6(-13)	8.0(-13)
16	-	2	0.0(0)	0.0(0)	3.2(-13)	1.8(-12)
16	-	3	0.0(0)	0.0(0)	7.9(-13)	3.0(-12)
16	-	4	0.0(0)	8.5(-13)	1.8(-12)	3.7(-12)
16	-	5	0.0(0)	1.9(-12)	2.2(-12)	4.6(-12)
16	-	6	3.6(-12)	9.7(-13)	4.3(-12)	6.3(-12)
16	-	7	4.5(-12)	6.1(-12)	7.0(-12)	8.8(-12)
16	-	8	4.1(-12)	5.0(-12)	7.7(-12)	1.4(-11)
16	-	9	2.9(-11)	1.7(-11)	1.6(-11)	1.7(-11)
16	-	10	1.3(-11)	1.9(-11)	1.7(-11)	2.0(-11)
16	-	11	5.0(-11)	2.8(-11)	2.3(-11)	2.0(-11)
16	-	12	2.2(-11)	2.7(-11)	2.7(-11)	3.2(-11)
16	-	13	5.8(-11)	3.7(-11)	3.2(-11)	3.5(-11)
16	-	14	6.6(-11)	4.6(-11)	4.2(-11)	4.8(-11)
16	-	15	6.1(-11)	7.2(-11)	8.4(-11)	1.1(-10)
16	-	17	5.0(-11)	7.0(-11)	7.8(-11)	9.6(-11)
16	-	18	1.8(-11)	2.6(-11)	3.3(-11)	4.5(-11)
16	-	19	9.3(-12)	1.5(-11)	2.2(-11)	3.2(-11)
16	-	20	6.2(-12)	1.0(-11)	1.6(-11)	2.5(-11)
16	-	21	3.0(-12)	7.5(-12)	1.3(-11)	1.8(-11)
16	-	22	1.7(-12)	3.9(-12)	8.7(-12)	1.5(-11)
16	-	23	8.2(-13)	3.2(-12)	8.0(-12)	1.4(-11)
17	-	0	0.0(0)	0.0(0)	0.0(0)	1.9(-13)
17	-	1	0.0(0)	0.0(0)	1.4(-13)	4.9(-13)
17	-	2	0.0(0)	0.0(0)	2.9(-13)	1.7(-12)
17	-	3	0.0(0)	1.2(-13)	1.0(-12)	1.5(-12)
17	-	4	0.0(0)	1.2(-13)	1.5(-12)	2.7(-12)
17	-	5	0.0(0)	6.4(-13)	1.3(-12)	3.4(-12)
17	-	6	0.0(0)	6.6(-13)	3.0(-12)	4.7(-12)
17	-	7	5.7(-12)	2.3(-12)	5.0(-12)	5.9(-12)
17	-	8	6.7(-12)	5.6(-12)	6.4(-12)	1.0(-11)
17	-	9	1.6(-11)	1.0(-11)	9.3(-12)	1.1(-11)
17	-	10	1.3(-11)	1.0(-11)	1.6(-11)	1.3(-11)
17	-	11	5.5(-11)	2.0(-11)	1.7(-11)	1.8(-11)
17	-	12	1.9(-11)	2.5(-11)	2.1(-11)	2.3(-11)
17	-	13	7.6(-11)	3.2(-11)	2.7(-11)	2.8(-11)
17	-	14	6.5(-11)	3.8(-11)	3.3(-11)	3.6(-11)
17	-	15	3.7(-11)	4.5(-11)	4.6(-11)	4.5(-11)
17	-	16	9.9(-11)	9.5(-11)	8.8(-11)	1.0(-10)
17	-	18	4.9(-11)	6.9(-11)	7.7(-11)	9.6(-11)
17	-	19	1.8(-11)	2.5(-11)	3.3(-11)	4.5(-11)
17	-	20	9.1(-12)	1.5(-11)	2.2(-11)	3.2(-11)
17	-	21	6.1(-12)	9.7(-12)	1.6(-11)	2.4(-11)
17	-	22	3.0(-12)	7.3(-12)	1.3(-11)	1.7(-11)
17	-	23	1.7(-12)	3.8(-12)	8.5(-12)	1.5(-11)

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TABLE 8—*Continued*

INITIAL	-	FINAL	10.0 K	20.0 K	40.0 K	80.0 K
18	-	0	0.0(0)	0.0(0)	0.0(0)	1.8(-13)
18	-	1	0.0(0)	0.0(0)	1.3(-13)	2.7(-13)
18	-	2	0.0(0)	1.1(-12)	0.0(0)	5.7(-13)
18	-	3	0.0(0)	0.0(0)	2.3(-13)	8.8(-13)
18	-	4	0.0(0)	1.6(-13)	7.1(-13)	2.0(-12)
18	-	5	0.0(0)	1.6(-13)	6.5(-13)	2.4(-12)
18	-	6	0.0(0)	1.9(-12)	1.3(-12)	4.1(-12)
18	-	7	0.0(0)	1.5(-12)	3.6(-12)	5.5(-12)
18	-	8	9.0(-12)	2.6(-12)	5.0(-12)	6.8(-12)
18	-	9	1.0(-11)	8.9(-12)	8.4(-12)	9.7(-12)
18	-	10	2.3(-11)	1.1(-11)	1.0(-11)	1.4(-11)
18	-	11	5.5(-11)	2.3(-11)	1.9(-11)	1.8(-11)
18	-	12	3.9(-12)	2.2(-11)	2.3(-11)	2.4(-11)
18	-	13	7.6(-11)	3.4(-11)	2.5(-11)	2.1(-11)
18	-	14	9.0(-11)	3.5(-11)	2.8(-11)	2.9(-11)
18	-	15	2.7(-11)	3.8(-11)	3.1(-11)	3.7(-11)
18	-	16	7.6(-11)	4.9(-11)	4.3(-11)	4.9(-11)
18	-	17	1.0(-10)	9.7(-11)	8.9(-11)	1.0(-10)
18	-	19	4.9(-11)	6.8(-11)	7.7(-11)	9.5(-11)
18	-	20	1.8(-11)	2.5(-11)	3.2(-11)	4.4(-11)
18	-	21	8.9(-12)	1.5(-11)	2.2(-11)	3.1(-11)
18	-	22	6.0(-12)	9.5(-12)	1.6(-11)	2.4(-11)
18	-	23	2.9(-12)	7.1(-12)	1.3(-11)	1.7(-11)
19	-	0	0.0(0)	0.0(0)	0.0(0)	1.7(-13)
19	-	1	0.0(0)	0.0(0)	0.0(0)	2.8(-13)
19	-	2	0.0(0)	0.0(0)	2.0(-13)	8.9(-13)
19	-	3	0.0(0)	0.0(0)	1.3(-13)	1.6(-12)
19	-	4	0.0(0)	0.0(0)	3.3(-13)	1.8(-12)
19	-	5	0.0(0)	2.2(-13)	9.5(-13)	3.4(-12)
19	-	6	0.0(0)	2.1(-13)	8.4(-13)	3.9(-12)
19	-	7	0.0(0)	1.5(-12)	2.0(-12)	4.4(-12)
19	-	8	0.0(0)	2.0(-12)	4.0(-12)	4.4(-12)
19	-	9	1.4(-11)	3.6(-12)	6.1(-12)	6.5(-12)
19	-	10	1.5(-11)	8.2(-12)	8.9(-12)	9.6(-12)
19	-	11	3.3(-11)	1.4(-11)	1.1(-11)	1.2(-11)
19	-	12	8.5(-12)	1.4(-11)	1.9(-11)	1.7(-11)
19	-	13	9.3(-11)	2.5(-11)	1.9(-11)	1.9(-11)
19	-	14	9.5(-11)	3.8(-11)	2.6(-11)	2.2(-11)
19	-	15	2.7(-11)	3.1(-11)	3.1(-11)	3.4(-11)
19	-	16	8.3(-11)	4.2(-11)	3.4(-11)	3.7(-11)
19	-	17	8.2(-11)	5.1(-11)	4.4(-11)	4.9(-11)
19	-	18	1.1(-10)	9.8(-11)	8.9(-11)	1.0(-10)
19	-	20	4.8(-11)	6.7(-11)	7.6(-11)	9.5(-11)
19	-	21	1.7(-11)	2.4(-11)	3.2(-11)	4.4(-11)
19	-	22	8.8(-12)	1.4(-11)	2.1(-11)	3.1(-11)

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TABLE 8—*Continued*

INITIAL - FINAL	10.0 K	20.0 K	40.0 K	80.0 K
20 - 0	0.0(0)	0.0(0)	0.0(0)	0.0(0)
20 - 1	0.0(0)	0.0(0)	0.0(0)	1.1(-13)
20 - 2	0.0(0)	0.0(0)	2.3(-13)	3.8(-13)
20 - 3	0.0(0)	0.0(0)	1.8(-13)	1.3(-12)
20 - 4	0.0(0)	0.0(0)	1.9(-13)	1.6(-12)
20 - 5	0.0(0)	0.0(0)	4.5(-13)	2.1(-12)
20 - 6	0.0(0)	3.1(-13)	2.0(-12)	3.0(-12)
20 - 7	0.0(0)	2.9(-13)	1.5(-12)	3.7(-12)
20 - 8	0.0(0)	1.9(-12)	2.5(-12)	4.1(-12)
20 - 9	0.0(0)	2.5(-12)	4.6(-12)	6.2(-12)
20 - 10	2.2(-11)	3.0(-12)	6.1(-12)	9.5(-12)
20 - 11	2.3(-11)	1.3(-11)	1.0(-11)	1.1(-11)
20 - 12	4.7(-11)	7.6(-12)	1.1(-11)	1.4(-11)
20 - 13	1.0(-10)	3.0(-11)	2.1(-11)	1.9(-11)
20 - 14	1.2(-10)	2.9(-11)	2.1(-11)	2.0(-11)
20 - 15	1.5(-11)	1.8(-11)	2.1(-11)	1.9(-11)
20 - 16	1.3(-10)	4.0(-11)	2.9(-11)	3.0(-11)
20 - 17	9.3(-11)	4.5(-11)	3.5(-11)	3.7(-11)
20 - 18	8.8(-11)	5.2(-11)	4.5(-11)	4.9(-11)
20 - 19	1.1(-10)	9.9(-11)	9.0(-11)	1.0(-10)
20 - 21	4.7(-11)	6.7(-11)	7.6(-11)	9.5(-11)
20 - 22	1.7(-11)	2.4(-11)	3.2(-11)	4.3(-11)
20 - 23	8.6(-12)	1.4(-11)	2.1(-11)	3.1(-11)

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