**RELATIVISTIC DISTORTED-WAVE COLLISION STRENGTHS
FOR THE 16 $\Delta n = 0$ OPTICALLY ALLOWED TRANSITIONS
WITH $n = 2$ IN THE 67 O-LIKE IONS WITH $26 \leq Z \leq 92$**

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Relativistic distorted-wave collision strengths have been calculated for the 16 $\Delta n = 0$ optically allowed transitions with $n = 2$ in the 67 O-like ions with nuclear charge number Z in the range $26 \leq Z \leq 92$. The calculations were made for the four final, or scattered, electron energies $E' = 0.20, 0.42, 0.80$, and 1.40 , where E' is in units of Z_{eff}^2 Ry with $Z_{\text{eff}} = Z - 5.83$. In the present calculations, an improved “top-up” method, which employs relativistic plane waves, was used to obtain the high partial-wave contribution for each transition, in contrast to the partial-relativistic Coulomb-Bethe approximation used in previous work by Zhang and Sampson [H.L. Zhang and D.H. Sampson, At. Data and Nucl. Data Tables 82 (2002) 357]. In that earlier work, collision strengths were also provided for O-like ions, but for a more comprehensive data set consisting of all possible 45 $\Delta n = 0$ transitions, six scattered energies, and the 79 ions with Z in the range $14 \leq Z \leq 92$. The collision strengths covered in the present work should be more accurate than the corresponding data given by Zhang and Sampson [H.L. Zhang and D.H. Sampson, At. Data and Nucl. Data Tables 82 (2002) 357] and are presented here to replace those earlier results.

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INTRODUCTION

This paper is the fifth in a series aimed at providing improved electron-impact excitation collision strengths for an isoelectronic sequence. The present work deals with O-like ions in a manner similar to that described in recently completed works on Be-like [2], B-like [3], C-like [4], and N-like [5] ions. O-like ions are of considerable interest for the study and modeling of high-temperature laboratory and astrophysical plasmas, and are prominent in the spectra of hot stellar coronae, the intracluster medium in galaxy groups, and in supernova remnants (SNRs) (see, e.g., [6–8]). Due to improved resolution in the measurement of x-ray, L-shell spectra expected with the upcoming launch of the Astro-H mission, the atomic physics data used in the collisional-radiative modeling of such objects require a more accurate treatment [8]. Young SNRs are of particular interest from a plasma modeling perspective because they provide an example of an “ionizing plasma” (i.e., the time to reach ionization equilibrium occurs on a millennial time scale) while these SNRs are only centuries old. In this case, O-like iron and nickel are abundant at much higher electron temperatures than they would be for steady-state-ionization plasmas and, as such, excitation rate coefficients sample the fundamental collision strengths at energies much higher than would normally be considered for thermal plasmas.

The previous example concerns iron, which represents the low end of the range of ions considered in this work ($Z = 26$). A potential application involving the high end of this range, uranium ($Z = 92$), concerns the collisional-radiative modeling of highly charged ion collisions produced by the experimental storage ring at GSI Darmstadt. Recent work [9] involved beams containing H-like uranium ions and provided experimental verification for such fundamental QED effects as the generalized Breit interaction. If such beams were to contain slightly lower charged O-like ions, then the present data may be important for the interpretation of such experiments.

For nuclear charge number Z greater than about 25 or 30, relativistic effects on the radial functions become significant for some transitions and a fully relativistic treatment based on the Dirac equation is preferable. Therefore, in Ref. [1], collision strengths were provided for all of the possible 45 transitions among the 10 levels arising from the $1s^22s^22p^4$, $1s^22s2p^5$, and $1s^22p^6$ configurations of all O-like ions with Z in the range

$$14 \leq Z \leq 92. \quad (1)$$

These previous results were calculated with an improved version [10] of the rapid relativistic distorted-wave (RDW) code of Ref. [11]. For additional details of our RDW

codes, a comprehensive review is available in Ref. [12]. These previous $\Delta n = 0$ calculations were made for the six final, or scattered, electron energies

$$E' = 0.03, 0.08, 0.20, 0.42, 0.80, \text{ and } 1.40, \quad (2)$$

where E' is in units of Z_{eff}^2 Rydbergs with

$$Z_{\text{eff}} = Z - 5.83. \quad (3)$$

The electric dipole oscillator strengths were also provided in Ref. [1]. We note that the precise choice for Z_{eff} is not very crucial. Equation (3) corresponds to the general formula $Z_{\text{eff}} = Z - (5/6)(N - 1)$ used in our previous work on other isoelectronic sequences, applied to the present case with $N = 8$. The range of energies covered by Eq. (2) is expected to include those of principal interest for determining collision rates for applications to high-temperature plasmas.

For optically allowed transitions in those earlier calculations, a partial-relativistic Coulomb-Bethe (PRCBe) approximation was used to estimate the high partial-wave contribution (sometimes referred to as the “top-up” in the literature). In this approximation, the non-relativistic Coulomb-Bethe procedure [13], as described by Eqs. (18)–(20) in Ref. [14], was used with the fully relativistic electric-dipole line strength S calculated with the multi-configuration Dirac-Fock (MCDHF) structure code of Grant and coworkers [15,16] (or by our Dirac-Fock-Slater structure code [17] in some cases). We note that the line strength S_{if} for a transition from level i to level f is related to the oscillator strength f_{if} , such as those listed in Table II of Ref. [1] for O-like ions, by

$$f_{if} = \frac{E_{if}}{3g_i} S_{if}, \quad (4)$$

where E_{if} is the transition energy in Rydbergs and $g_i = 2J_i + 1$ is the statistical weight, with J_i being the total angular momentum quantum number of the level i . The PRCBe approximation gives converged results, but omits the relativistic effects associated with the continuum electrons. Therefore, this approach is only accurate for (1) ions with low Z values and (2) low incident-electron energies. Furthermore, numerical studies have shown that this approach is also adequate in determining the top-up contribution for most $\Delta n > 0$ optically allowed transitions from low-lying levels, for which the transition energies are large and the top-up is typically a much smaller percentage of the total collision strength as compared to $\Delta n = 0$ transitions. On the other hand, for $\Delta n = 0$ allowed transitions, such as those considered in Ref. [1], the collision strengths obtained

with this procedure may not be very accurate for high- Z ions and for high incident-electron energies. Therefore, it is desirable to retain the PRCBe top-up approach at low incident energies for the present ions of interest, but, as the ion charge increases, a more accurate relativistic approach is required at high incident energies (see, also, the discussion on p. 147 of Ref. [12]).

In a recent publication, we derived an expression for the complete electron-impact excitation collision strength in the relativistic plane-wave Born (RPWB) approximation [18]. (By “complete” we indicate that the calculated value of the collision strength is consistent with a summation over an infinite number of partial waves for the initial and final continuum electrons.) This result can be readily used to obtain the high partial-wave contribution to the RDW collision strengths by assuming that the RDW high partial waves can be adequately approximated by the corresponding RPWB high partial waves. If this approximation is valid, then the complete RDW collision strength can be accurately calculated using the Kummer transformation [19] (see Eq. (4.75) of Ref. [12] and the surrounding discussion for more details). Using this top-up procedure, the complete RDW collision strength can be written in the form

$$\Omega^{\text{RDW}} \approx \sum_{l=0}^{l_0} \Omega_l^{\text{RDW}} + (\Omega^{\text{RPWB}} - \sum_{l=0}^{l_0} \Omega_l^{\text{RPWB}}), \quad (5)$$

where the l index denotes a partial wave of the incident-electron wavefunction. The prescribed value l_0 indicates the maximum partial wave to be explicitly calculated. (The summation over the j quantum number associated with the incident electron, as well as the summation over the corresponding l' and j' quantum numbers associated with the scattered electron, has already been performed.) The l and j quantum numbers are related to the usual relativistic quantum number κ by

$$\kappa = l, \quad j = l - \frac{1}{2}; \quad \kappa = -(l+1), \quad j = l + \frac{1}{2}. \quad (6)$$

For additional details concerning this RPWB top-up procedure, the reader is directed to Refs. [2, 12].

In view of this new, more accurate top-up capability, we investigated its effect on our previously published $\Delta n = 0$, O-like collision strengths. Significant improvements were found for the optically allowed transitions, while the effect on the other $\Delta n = 0$ transitions was negligible. Therefore, we have repeated the calculations of the collision strength for the 16 optically allowed $\Delta n = 0$ transitions with $n = 2$ for the four highest energies in O-like ions with higher Z values. More specifically, the new calculations were

done for Z in the range

$$26 \leq Z \leq 92 \quad (7)$$

and for the four scattered electron energies

$$E' = 0.20, 0.42, 0.80, \text{ and } 1.40. \quad (8)$$

The procedures used in the present calculations for the RDW part are the same as those used in the previous calculations of O-like ions [1], as well as those used for Be-like [2, 20], B-like [3, 21, 22], C-like [4, 23, 24], and N-like [5, 25] ions. That is, relativistic atomic structure data obtained with the “average level” option of the MCDF code of Grant and coworkers [15, 16] was used and the central potential used in solving the Dirac equation for the free-electron orbitals was the relativistic version of the potential used by Mann in his extensive semi-relativistic calculations [26, 27]. We evaluate this potential using a mean configuration, which in the present calculations was chosen to be the same as that appearing in Eq. (4) of Ref. [1]. That is,

$$1s_{1/2}^2 \ 2s_{1/2}^{1.8} \ 2p_{1/2}^{1.8} \ 2p_{3/2}^{2.4} \quad (9)$$

was used to obtain wavefunctions for both the impacting and scattered electrons.

As in our previous work, the results are given in terms of collision strengths. The relation between the collision strength $\Omega(i - f)$ and the cross section $Q(i - f)$ for a transition $i - f$ is

$$Q(i - f) = \frac{\pi a_0^2}{k_i^2 g_i} \Omega(i - f), \quad (10)$$

where a_0 is the Bohr radius, g_i is the statistical weight of the initial level and k_i is the relativistic wavenumber of the impacting electron in atomic units. The relation between k_i and the relativistic kinetic energy $\epsilon_i(\text{Ry})$ of the impact electron is

$$k_i^2 = \epsilon_i(\text{Ry}) \left[1 + \frac{\alpha^2}{4} \epsilon_i(\text{Ry}) \right], \quad (11)$$

where $\alpha = e^2/\hbar c$ is the fine-structure constant and $\epsilon_i(\text{Ry})$ is determined from the equation

$$\epsilon_i(\text{Ry}) = E_{if}(\text{Ry}) + Z_{\text{eff}}^2 E', \quad (12)$$

in which E_{if} is the transition energy, Z_{eff} is given by Eq. (3) and, in the present application, the final electron energy E' takes on the values given by Eq. (8).

As in Refs. [1–5,20–25], we use the factorization formulation of Bar-Shalom *et al.* [28] to express the collision strengths in the form

$$\Omega = 8 \sum_{\substack{j_a, j'_a \\ j_{a1}, j'_{a1}}} \sum_{\lambda} B^{\lambda}(j_a j'_a, j_{a1} j'_{a1}) Q^{\lambda}(j_a j'_a, j_{a1} j'_{a1}), \quad (13)$$

where the abbreviations $j_a = n_a l_a j_a$, $j'_a = n'_a l'_a j'_a$, $j_{a1} = n_{a1} l_{a1} j_{a1}$, and $j'_{a1} = n'_{a1} l'_{a1} j'_{a1}$ have been used. Here, j_a and j_{a1} represent orbitals in the initial target-ion wavefunction, while j'_a and j'_{a1} represent orbitals in the final target-ion wavefunction. A convenient feature of Eq. (13) is that the B^{λ} are functions only of the target-ion quantum numbers and mixing coefficients plus λ , while Q^{λ} contains the radial contribution and depends only on λ and the bound and free orbitals, with the summation over the free-electron angular momentum quantum numbers l , j , l' , and j' performed within it. (See, for example, Eqs. (10), (21), and (23) of Ref. [28].) Of course, in the present calculations we used the Kummer transformation, Eq. (5), to obtain the contribution for high partial waves denoted by l values greater than some suitably large value l_0 , up to which the RDW portion of the calculation was performed. We note that rather large values of l_0 (51, 58, 61, and 65) were used for the four scattered energies given in Eq. (8) to ensure that the free-electron partial waves with $l > l_0$ can be accurately represented by plane-wave functions in order to obtain collision strengths that are physically accurate. These l_0 values are almost the same as those reported in Ref. [1].

A list of energy level labels is provided in Table 1. In the present work, mixing was included among all states in a group, where each group consists of all states in a complex (i.e., those states having the same set of n values, parity, and J value). We designate each group by a capital letter, as listed in Table 1. A number subscript to the group letter designates a particular energy level in the group. Both the dominant jj -coupled state and the dominant LS -coupled state contributing to each level are indicated in the table, which was partially reproduced from Table I in Ref. [1]. For the jj -coupled basis states, “ $2p^*$ ” means $2p_{1/2}$ and “ $2p$ ” means $2p_{3/2}$. Note that we have not provided the corresponding oscillator strengths in this work. See Table II in Ref. [1] for those data. The collision strengths for all 16 optically allowed transitions among the $n = 2$ levels in O-like ions with Z values in the range specified by Eq. (7) are given in Table 2. The transition energies E_{if} in eV are also included in this table.

For each of the four scattered electron energies given by Eq. (8), detailed calculations of the Q^{λ} values were made for several transition energies that span the range of physical transition energies. Then these results were used to obtain Q^{λ} values at the exact energy

of each transition via Lagrange interpolation. In most of our earlier work, accurate values (to within about 1%) could be obtained by performing detailed calculations for only three transition energies and using these values in a 3-point interpolation. But in the present case, in order to obtain results as accurate as possible, we performed detailed calculations for five transition energies that cover the range of all physical transition energies for a given Z value. Then, for each physical transition energy, results were obtained by using Q^λ values at the three energy points nearest to that exact transition energy in a 3-point interpolation.

Before considering the collision strength data in Table 2, we briefly discuss the important practical issue of the relation between the collision strength $\Omega(i-f)$ and the rate coefficient C_{if} when a relativistic Maxwellian electron distribution function is assumed. As follows from the work in Refs. [29] and [30] (see also Section 4.14 of Ref. [12]), this relation is given by

$$\begin{aligned} C_{if} &= \alpha \pi a_0^2 \sqrt{\frac{2kT}{m}} \sqrt{\frac{I_H}{kT}} \frac{\Upsilon_{if}}{g_i \exp(mc^2/kT) K_2(mc^2/kT)} \exp(-E_{if}/kT) \\ &= 2\pi^{1/2} \alpha c a_0^2 \sqrt{\frac{I_H}{kT}} \frac{\Upsilon_{if}}{g_i G(kT/mc^2)} \exp(-E_{if}/kT), \end{aligned} \quad (14)$$

where I_H is one Rydberg, $K_2(mc^2/kT)$ is the modified Bessel function of order 2 and Υ_{if} is the effective collision strength defined by

$$\Upsilon_{if} \equiv \int_0^\infty \Omega(i-f) \exp(-\epsilon_f/kT) d(\epsilon_f/kT), \quad (15)$$

in which $\epsilon_f = Z_{\text{eff}}^2 E'$ is the final, or scattered, electron energy in Rydbergs. In the second line of Eq. (14), the value of $2\pi^{1/2} \alpha c a_0^2$ can be expressed as $2.1717 \times 10^{-8} \text{cm}^3 \text{s}^{-1}$ in cgs units. Furthermore, that line has the same form as the non-relativistic expression given, for example, by Eq. (3) of Ref. [31], except for the presence of the function $G(kT/mc^2)$, which is defined by

$$G(kT/mc^2) \equiv \sqrt{\frac{2}{\pi} \left(\frac{mc^2}{kT} \right)} \exp(mc^2/kT) K_2(mc^2/kT). \quad (16)$$

For plasmas that satisfy the condition $kT/mc^2 < 1$, which is true for a broad range of cases of interest, one can expand the modified Bessel function using Eq. (9.72) of Ref. [19] to obtain

$$G(kT/mc^2) = 1 + \frac{15}{8} \frac{kT}{mc^2} + \frac{105}{128} \left(\frac{kT}{mc^2} \right)^2 - \frac{315}{1024} \left(\frac{kT}{mc^2} \right)^3 + \frac{10395}{32768} \left(\frac{kT}{mc^2} \right)^4 + \dots \quad (17)$$

Figure 1: A plot of collision strengths for the $A_2 - E_2$ transition in O-like xenon ($Z = 54$) and uranium ($Z = 92$). The solid lines represent collision strengths calculated with the RPWB top-up method presented in Eq. (5), while the dashed lines represent collision strengths calculated with the PRCBe method.

Finally, we note that in writing Eq. (14), it was assumed that i is the lower level. If this is not the case, then the exponential factor should be omitted.

Comparing the collision strength data in Table 2 of the present work with that in Table III of Ref. [1], one sees that for lower Z values, the agreement is quite good. Also, for the lowest scattered energy in Table 2, $E' = 0.2 Z_{\text{eff}}^2 \text{ Ry}$, the agreement is also very good over the entire range of Z values. However, for higher energies, especially for the largest value of $E' = 1.4 Z_{\text{eff}}^2 \text{ Ry}$, the new results become progressively larger with increasing Z value, up to a 28.7% increase. As an illustration of this behavior, we present collision strengths for the $A_2 - E_2$ transition in O-like xenon ($Z = 54$) and uranium ($Z = 92$) in Fig. 1. The separation between the RPWB and PRCBe curves clearly increases with increasing impact energy for both xenon and uranium. As expected, the separation is larger (on a percentage basis) for uranium, since the relativistic effects are greater for heavier ions, with a maximum difference of 28.5% observed at the highest impact energy.

While the O-like ions with the highest Z values presently under consideration can require the inclusion of QED effects in order to obtain accurate collision strengths, the

work in Ref. [32] indicates that the omission of the generalized Breit interaction in the calculation of the scattering matrix elements, as we have done here, is completely valid for the present application involving $\Delta n = 0$ transitions. Also, due to the relatively large charge of the ions under consideration, the effect of radiation damping will be significant and resonance contributions are not expected to be very important for the present optically allowed transitions over most of the Z range. (See additional discussion of resonances below.) In conclusion, we expect that the present results for the 16 $\Delta n = 0$ transitions currently under consideration should be quite accurate for the range of ions and energies given in Eqs. (7) and (8). We note that, as mentioned in other work (see, for example, Ref. [23]), our collision strengths for the low- Z end of the range of ions considered in Ref. [1] could be inaccurate by about 20% due to the omission of mixing with $n \geq 3$ configurations. However, this configuration interaction effect should become progressively less important for the present results as the Z value increases through the higher range of $26 \leq Z \leq 92$.

In Ref. [1], some additional discussions, as well as comparisons to other works (see the references therein) were provided. These discussions and comparisons are still valid. Since the publication of that earlier work, additional excitation data, obtained with different approaches to the close-coupling R-matrix method, have been published that contain results for O-like iron [33–35]. As expected, these three works illustrated that resonances can provide a significant contribution to the collision strengths of forbidden, $\Delta n = 0$ transitions. In general, one expects that results computed with the R-matrix method should be more accurate for low- Z ions, due to a more complete description of resonances and continuum coupling. However, for the highly charged ions and dipole allowed transitions considered in the present work, the RDW data should be of similar, or better, accuracy compared to the corresponding R-matrix data. More specifically, the importance of the resonance contribution to excitation cross sections for dipole allowed transitions diminishes as the ion charge increases (due to radiation damping [36, 37]) and also as the impact energy increases (no resonances can occur if the impact energy is above the relevant ionization threshold). If the energy is large enough that resonances are not present in the cross section, then the top-up method discussed in this work is expected to produce more accurate results than semi-relativistic top-up methods when a fully relativistic description of the continuum electrons is warranted. If the energy is low enough to allow resonances, the RDW data should agree well with the background contribution to the corresponding R-matrix data for these highly charged ions, and the effect of resonances will either be negligible due to radiation damping or, for the

weaker transitions, the effect can be accurately included in the RDW calculations via the independent-process, isolated-resonance method [12, 37–39].

The complete set of results for all 79 Z values specified in Eq. (1) and all 6 energies specified in Eq. (2), with the present results (Table 2), replacing the corresponding values in Table III of Ref. [1], is available electronically by writing to the authors at cjf@lanl.gov. The present data are also available at the journal’s Web Page as ASCII files.

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EXPLANATION OF TABLES

TABLE 1. Labeling of Energy Levels

This table shows the jj -coupled basis state and the LS -coupled basis state that make the dominant contribution to each energy level for Z in the range $26 \leq Z \leq 92$. For the jj -coupled basis states, “ $2p^*$ ” means $2p_{1/2}$ and “ $2p$ ” means $2p_{3/2}$, so that “ $(2s2p^*2p^3)_1$ ” means $(1s^22s2p_{1/2}^22p_{3/2}^3)_1$ with $1s^2$ omitted. For LS -coupled basis states, “ $2s2p^5\ ^3P_1$ ” means $1s^22s2p^5\ ^3P_1$.

TABLE 2. Collision Strengths as a Function of Scattered Electron Energy E'

Table 2 gives values for the collision strengths from which one can obtain values for the cross sections using Eqs. (10)–(12) or the rate coefficients using Eqs. (14)–(17). All Z values in the range $26 \leq Z \leq 92$ are included. In the present case the statistical weight $g_i = 2J_i + 1$, where J_i is the value for the total angular momentum quantum number for the initial level. The fine-structure constant α in Eq. (14) has the value $1/137.036$. The Z_{eff} in Eq. (12) is given by Eq. (3) and the transition energy $E_{if}(\text{Ry})$ in Eq. (12) is obtained from the corresponding entry in eV given in Table 2 by dividing by the conversion factor 13.6057 eV/Ry . When the entry for E_{if} is negative, the level f is the lower level and the cross section for the excitation transition $f - i$ is obtained by using Eqs. (10)–(12) with i and f interchanged.

Z	Nuclear charge number
if	Initial (lower) and final (upper) levels, labeled according to Table 1
E_{if}	Transition energy in eV
E'	Scattered electron energy in units of $Z_{\text{eff}}^2 \text{Ry}$, where the effective nuclear charge Z_{eff} is given by $Z - 5.83$ [Eq. (3)]

TABLE 1: Labeling of Energy Levels

Energy level	Dominant jj State $26 \leq Z \leq 92$	Dominant LS State		
		$26 \leq Z \leq 36$	$37 \leq Z \leq 49$	$50 \leq Z \leq 92$
A_1	$[2s^2 2p^{*2} (2p^2)_0]_0$	$2s^2 2p^4 {}^3P_0$	$2s^2 2p^4 {}^1S_0$	$2s^2 2p^4 {}^1S_0$
A_2	$(2s^2 2p^4)_0$	$2s^2 2p^4 {}^1S_0$	$2s^2 2p^4 {}^3P_0$	$2s^2 2p^4 {}^3P_0$
A_3	$(2p^{*2} 2p^4)_0$	$2p^6 {}^1S_0$	$2p^6 {}^1S_0$	$2p^6 {}^1S_0$
B_1	$(2s^2 2p^* 2p^3)_1$	$2s^2 2p^4 {}^3P_1$	$2s^2 2p^4 {}^3P_1$	$2s^2 2p^4 {}^3P_1$
C_1	$[2s^2 2p^{*2} (2p^2)_2]_2$	$2s^2 2p^4 {}^3P_2$	$2s^2 2p^4 {}^3P_2$	$2s^2 2p^4 {}^3P_2$
C_2	$(2s^2 2p^* 2p^3)_2$	$2s^2 2p^4 {}^1D_2$	$2s^2 2p^4 {}^1D_2$	$2s^2 2p^4 {}^1D_2$
D_1	$(2s 2p^* 2p^4)_0$	$2s 2p^5 {}^3P_0$	$2s 2p^5 {}^3P_0$	$2s 2p^5 {}^3P_0$
E_1	$(2s 2p^{*2} 2p^3)_1$	$2s 2p^5 {}^3P_1$	$2s 2p^5 {}^3P_1$	$2s 2p^5 {}^1P_1$
E_2	$(2s 2p^* 2p^4)_1$	$2s 2p^5 {}^1P_1$	$2s 2p^5 {}^1P_1$	$2s 2p^5 {}^3P_1$
F_1	$(2s 2p^{*2} 2p^3)_2$	$2s 2p^5 {}^3P_2$	$2s 2p^5 {}^3P_2$	$2s 2p^5 {}^3P_2$

TABLE 2. Collision Strengths as a Function of Scattered Electron Energy E'

See page 14 for Explanation of Tables

$A_1 - E_1$						$A_1 - E_2$					
Z	E_{if}	$E'=0.20$	$E'=0.42$	$E'=0.80$	$E'=1.40$	Z	E_{if}	$E'=0.20$	$E'=0.42$	$E'=0.80$	$E'=1.40$
26	113.94	1.84E-1	2.16E-1	2.49E-1	2.80E-1	26	150.64	7.62E-3	8.52E-3	9.65E-3	1.08E-2
27	121.41	1.67E-1	1.96E-1	2.25E-1	2.54E-1	27	159.73	7.83E-3	8.83E-3	1.00E-2	1.13E-2
28	129.35	1.52E-1	1.78E-1	2.05E-1	2.31E-1	28	169.40	7.80E-3	8.86E-3	1.01E-2	1.14E-2
29	137.79	1.39E-1	1.63E-1	1.88E-1	2.11E-1	29	179.73	7.55E-3	8.61E-3	9.84E-3	1.11E-2
30	146.76	1.27E-1	1.50E-1	1.72E-1	1.94E-1	30	190.81	7.10E-3	8.12E-3	9.30E-3	1.05E-2
31	156.29	1.18E-1	1.38E-1	1.59E-1	1.80E-1	31	202.72	6.49E-3	7.45E-3	8.54E-3	9.66E-3
32	166.40	1.09E-1	1.28E-1	1.48E-1	1.67E-1	32	215.54	5.78E-3	6.65E-3	7.64E-3	8.65E-3
33	177.12	1.02E-1	1.20E-1	1.38E-1	1.56E-1	33	229.37	5.03E-3	5.80E-3	6.67E-3	7.57E-3
34	188.46	9.55E-2	1.12E-1	1.30E-1	1.47E-1	34	244.28	4.28E-3	4.94E-3	5.69E-3	6.47E-3
35	200.46	8.97E-2	1.05E-1	1.22E-1	1.38E-1	35	260.37	3.57E-3	4.13E-3	4.76E-3	5.42E-3
36	213.13	8.52E-2	9.93E-2	1.15E-1	1.31E-1	36	277.75	2.93E-3	3.40E-3	3.91E-3	4.45E-3
37	226.52	8.04E-2	9.39E-2	1.08E-1	1.24E-1	37	296.50	2.36E-3	2.75E-3	3.16E-3	3.60E-3
38	240.66	7.61E-2	8.90E-2	1.03E-1	1.17E-1	38	316.72	1.88E-3	2.19E-3	2.52E-3	2.88E-3
39	255.58	7.21E-2	8.44E-2	9.77E-2	1.12E-1	39	338.52	1.48E-3	1.73E-3	1.99E-3	2.28E-3
40	271.33	6.85E-2	8.02E-2	9.30E-2	1.06E-1	40	362.00	1.16E-3	1.35E-3	1.56E-3	1.78E-3
41	287.96	6.51E-2	7.64E-2	8.86E-2	1.02E-1	41	387.26	8.95E-4	1.04E-3	1.21E-3	1.39E-3
42	305.52	6.19E-2	7.27E-2	8.44E-2	9.71E-2	42	414.40	6.89E-4	8.04E-4	9.30E-4	1.07E-3
43	324.06	5.90E-2	6.94E-2	8.06E-2	9.29E-2	43	443.55	5.29E-4	6.16E-4	7.14E-4	8.23E-4
44	343.64	5.62E-2	6.62E-2	7.70E-2	8.90E-2	44	474.81	4.04E-4	4.71E-4	5.46E-4	6.31E-4
45	364.33	5.37E-2	6.32E-2	7.37E-2	8.53E-2	45	508.30	3.08E-4	3.58E-4	4.16E-4	4.82E-4
46	386.19	5.13E-2	6.04E-2	7.05E-2	8.18E-2	46	544.15	2.35E-4	2.72E-4	3.17E-4	3.68E-4
47	409.29	4.91E-2	5.78E-2	6.76E-2	7.85E-2	47	582.48	1.79E-4	2.07E-4	2.41E-4	2.80E-4
48	433.69	4.71E-2	5.53E-2	6.48E-2	7.55E-2	48	623.42	1.36E-4	1.57E-4	1.83E-4	2.13E-4
49	459.46	4.52E-2	5.30E-2	6.21E-2	7.25E-2	49	667.11	1.04E-4	1.19E-4	1.39E-4	1.62E-4
50	486.70	4.34E-2	5.07E-2	5.96E-2	6.98E-2	50	713.71	7.89E-5	9.02E-5	1.05E-4	1.23E-4
51	515.46	4.15E-2	4.84E-2	5.71E-2	6.72E-2	51	763.34	6.00E-5	6.83E-5	7.99E-5	9.38E-5
52	545.83	4.00E-2	4.66E-2	5.50E-2	6.48E-2	52	816.17	4.57E-5	5.19E-5	6.07E-5	7.14E-5
53	577.91	3.82E-2	4.49E-2	5.30E-2	6.25E-2	53	872.38	3.47E-5	3.95E-5	4.61E-5	5.43E-5
54	611.77	3.64E-2	4.32E-2	5.10E-2	6.03E-2	54	932.10	2.64E-5	3.00E-5	3.50E-5	4.14E-5
55	647.50	3.47E-2	4.15E-2	4.92E-2	5.82E-2	55	995.53	2.01E-5	2.28E-5	2.66E-5	3.15E-5
56	685.21	3.32E-2	3.99E-2	4.74E-2	5.62E-2	56	1062.84	1.53E-5	1.74E-5	2.02E-5	2.40E-5
57	724.98	3.19E-2	3.84E-2	4.57E-2	5.43E-2	57	1134.23	1.17E-5	1.33E-5	1.54E-5	1.83E-5
58	766.92	3.07E-2	3.69E-2	4.40E-2	5.25E-2	58	1209.89	9.01E-6	1.01E-5	1.17E-5	1.39E-5
59	811.14	2.96E-2	3.55E-2	4.25E-2	5.08E-2	59	1290.03	6.93E-6	7.72E-6	8.94E-6	1.06E-5
60	857.73	2.85E-2	3.41E-2	4.10E-2	4.92E-2	60	1374.85	5.36E-6	5.90E-6	6.81E-6	8.12E-6
61	906.82	2.75E-2	3.29E-2	3.95E-2	4.76E-2	61	1464.59	4.15E-6	4.51E-6	5.19E-6	6.20E-6
62	958.51	2.65E-2	3.17E-2	3.82E-2	4.61E-2	62	1559.45	3.22E-6	3.46E-6	3.96E-6	4.73E-6
63	1012.95	2.56E-2	3.06E-2	3.68E-2	4.46E-2	63	1659.70	2.49E-6	2.65E-6	3.03E-6	3.61E-6
64	1070.24	2.46E-2	2.96E-2	3.56E-2	4.32E-2	64	1765.56	1.94E-6	2.04E-6	2.32E-6	2.76E-6
65	1130.53	2.37E-2	2.85E-2	3.44E-2	4.19E-2	65	1877.32	1.52E-6	1.57E-6	1.77E-6	2.11E-6
66	1193.95	2.28E-2	2.76E-2	3.33E-2	4.06E-2	66	1995.22	1.20E-6	1.21E-6	1.35E-6	1.61E-6
67	1260.64	2.19E-2	2.66E-2	3.22E-2	3.94E-2	67	2119.57	9.51E-7	9.37E-7	1.04E-6	1.23E-6
68	1330.76	2.11E-2	2.57E-2	3.12E-2	3.83E-2	68	2250.65	7.57E-7	7.28E-7	7.94E-7	9.40E-7
69	1404.46	2.03E-2	2.48E-2	3.02E-2	3.72E-2	69	2388.76	6.06E-7	5.67E-7	6.09E-7	7.18E-7
70	1481.87	1.96E-2	2.40E-2	2.92E-2	3.61E-2	70	2534.21	4.87E-7	4.43E-7	4.68E-7	5.49E-7
71	1563.21	1.89E-2	2.31E-2	2.83E-2	3.51E-2	71	2687.36	3.95E-7	3.49E-7	3.61E-7	4.21E-7
72	1648.61	1.82E-2	2.24E-2	2.74E-2	3.41E-2	72	2848.52	3.22E-7	2.76E-7	2.79E-7	3.22E-7
73	1738.28	1.76E-2	2.16E-2	2.66E-2	3.31E-2	73	3018.07	2.65E-7	2.20E-7	2.16E-7	2.47E-7
74	1832.39	1.70E-2	2.09E-2	2.57E-2	3.22E-2	74	3196.39	2.20E-7	1.77E-7	1.68E-7	1.90E-7
75	1931.16	1.64E-2	2.02E-2	2.49E-2	3.13E-2	75	3383.86	1.84E-7	1.43E-7	1.32E-7	1.47E-7
76	2034.76	1.59E-2	1.95E-2	2.42E-2	3.04E-2	76	3580.87	1.55E-7	1.16E-7	1.04E-7	1.14E-7
77	2143.45	1.53E-2	1.88E-2	2.35E-2	2.96E-2	77	3787.90	1.32E-7	9.57E-8	8.23E-8	8.87E-8
78	2257.43	1.48E-2	1.82E-2	2.27E-2	2.88E-2	78	4005.36	1.14E-7	7.95E-8	6.59E-8	6.95E-8
79	2376.94	1.43E-2	1.76E-2	2.21E-2	2.80E-2	79	4233.74	9.83E-8	6.65E-8	5.33E-8	5.48E-8
80	2502.20	1.39E-2	1.70E-2	2.14E-2	2.73E-2	80	4473.48	8.57E-8	5.63E-8	4.35E-8	4.37E-8
81	2633.47	1.34E-2	1.65E-2	2.08E-2	2.66E-2	81	4725.12	7.50E-8	4.82E-8	3.60E-8	3.52E-8
82	2771.06	1.30E-2	1.59E-2	2.01E-2	2.59E-2	82	4989.21	6.62E-8	4.16E-8	3.00E-8	2.87E-8
83	2915.25	1.26E-2	1.54E-2	1.95E-2	2.52E-2	83	5266.33	5.88E-8	3.63E-8	2.54E-8	2.37E-8
84	3066.36	1.22E-2	1.49E-2	1.90E-2	2.45E-2	84	5557.11	5.24E-8	3.19E-8	2.18E-8	1.99E-8
85	3224.63	1.18E-2	1.45E-2	1.84E-2	2.39E-2	85	5862.06	4.69E-8	2.83E-8	1.89E-8	1.69E-8
86	3390.01	1.14E-2	1.40E-2	1.79E-2	2.33E-2	86	6181.45	4.22E-8	2.52E-8	1.66E-8	1.46E-8
87	3563.58	1.10E-2	1.36E-2	1.73E-2	2.27E-2	87	6516.77	3.81E-8	2.26E-8	1.47E-8	1.28E-8
88	3745.26	1.07E-2	1.32E-2	1.68E-2	2.21E-2	88	6868.24	3.44E-8	2.05E-8	1.31E-8	1.13E-8
89	3935.58	1.03E-2	1.28E-2	1.63E-2	2.15E-2	89	7236.80	3.13E-8	1.85E-8	1.18E-8	1.01E-8
90	4134.65	9.95E-3	1.24E-2	1.59E-2	2.10E-2	90	7622.91	2.85E-8	1.69E-8	1.08E-8	9.18E-9
91	4343.38	9.61E-3	1.20E-2	1.54E-2	2.04E-2	91	8027.98	2.60E-8	1.54E-8	9.83E-9	8.40E-9
92	4561.41	9.29E-3	1.16E-2	1.50E-2	1.99E-2	92	8452.02	2.38E-8	1.41E-8	9.03E-9	7.73E-9

TABLE 2. Collision Strengths as a Function of Scattered Electron Energy E'

See page 14 for Explanation of Tables

$A_2 - E_1$						$A_2 - E_2$					
Z	E_{if}	$E'=0.20$	$E'=0.42$	$E'=0.80$	$E'=1.40$	Z	E_{if}	$E'=0.20$	$E'=0.42$	$E'=0.80$	$E'=1.40$
26	83.31	2.67E-2	3.04E-2	3.42E-2	3.81E-2	26	120.02	1.07E-1	1.25E-1	1.44E-1	1.62E-1
27	87.11	2.80E-2	3.20E-2	3.62E-2	4.03E-2	27	125.43	1.00E-1	1.17E-1	1.35E-1	1.52E-1
28	90.71	2.87E-2	3.29E-2	3.72E-2	4.15E-2	28	130.76	9.42E-2	1.10E-1	1.27E-1	1.43E-1
29	94.06	2.87E-2	3.29E-2	3.73E-2	4.17E-2	29	136.01	8.93E-2	1.05E-1	1.20E-1	1.36E-1
30	97.12	2.80E-2	3.22E-2	3.66E-2	4.10E-2	30	141.18	8.52E-2	1.00E-1	1.15E-1	1.29E-1
31	99.84	2.68E-2	3.10E-2	3.52E-2	3.94E-2	31	146.27	8.18E-2	9.59E-2	1.10E-1	1.24E-1
32	102.17	2.53E-2	2.92E-2	3.32E-2	3.72E-2	32	151.32	7.89E-2	9.26E-2	1.06E-1	1.20E-1
33	104.07	2.34E-2	2.71E-2	3.08E-2	3.46E-2	33	156.32	7.64E-2	8.96E-2	1.03E-1	1.16E-1
34	105.48	2.14E-2	2.48E-2	2.83E-2	3.17E-2	34	161.29	7.42E-2	8.71E-2	1.00E-1	1.13E-1
35	106.36	1.94E-2	2.25E-2	2.56E-2	2.88E-2	35	166.27	7.22E-2	8.47E-2	9.75E-2	1.10E-1
36	106.64	1.72E-2	2.01E-2	2.30E-2	2.59E-2	36	171.26	7.08E-2	8.21E-2	9.47E-2	1.07E-1
37	106.29	1.53E-2	1.79E-2	2.06E-2	2.32E-2	37	176.27	6.89E-2	8.00E-2	9.23E-2	1.05E-1
38	105.26	1.36E-2	1.60E-2	1.83E-2	2.06E-2	38	181.32	6.71E-2	7.79E-2	8.99E-2	1.02E-1
39	103.48	1.21E-2	1.42E-2	1.62E-2	1.83E-2	39	186.42	6.52E-2	7.58E-2	8.76E-2	9.98E-2
40	100.92	1.07E-2	1.26E-2	1.44E-2	1.63E-2	40	191.58	6.33E-2	7.37E-2	8.53E-2	9.72E-2
41	97.51	9.50E-3	1.12E-2	1.28E-2	1.44E-2	41	196.81	6.15E-2	7.16E-2	8.29E-2	9.47E-2
42	93.22	8.46E-3	9.95E-3	1.14E-2	1.29E-2	42	202.10	5.96E-2	6.96E-2	8.06E-2	9.21E-2
43	87.98	7.56E-3	8.90E-3	1.02E-2	1.15E-2	43	207.47	5.78E-2	6.75E-2	7.82E-2	8.96E-2
44	81.75	6.81E-3	8.00E-3	9.16E-3	1.03E-2	44	212.91	5.59E-2	6.54E-2	7.59E-2	8.71E-2
45	74.46	6.17E-3	7.24E-3	8.28E-3	9.35E-3	45	218.43	5.41E-2	6.33E-2	7.36E-2	8.46E-2
46	66.07	5.64E-3	6.61E-3	7.54E-3	8.52E-3	46	224.02	5.23E-2	6.13E-2	7.13E-2	8.21E-2
47	56.51	5.22E-3	6.09E-3	6.94E-3	7.83E-3	47	229.69	5.05E-2	5.93E-2	6.91E-2	7.97E-2
48	45.71	4.90E-3	5.69E-3	6.46E-3	7.29E-3	48	235.45	4.88E-2	5.74E-2	6.70E-2	7.74E-2
49	33.63	4.70E-3	5.42E-3	6.13E-3	6.90E-3	49	241.28	4.71E-2	5.55E-2	6.49E-2	7.51E-2
50	20.18	4.69E-3	5.36E-3	6.01E-3	6.75E-3	50	247.19	4.57E-2	5.38E-2	6.29E-2	7.29E-2
51	5.296	5.33E-3	5.95E-3	6.60E-3	7.35E-3	51	253.18	4.41E-2	5.20E-2	6.08E-2	7.07E-2
52	-11.09	4.26E-3	4.82E-3	5.38E-3	6.04E-3	52	259.25	4.27E-2	5.04E-2	5.90E-2	6.86E-2
53	-29.06	3.23E-3	3.71E-3	4.20E-3	4.76E-3	53	265.41	4.10E-2	4.86E-2	5.71E-2	6.66E-2
54	-48.69	2.63E-3	3.06E-3	3.50E-3	4.00E-3	54	271.64	3.98E-2	4.71E-2	5.53E-2	6.47E-2
55	-70.06	2.21E-3	2.60E-3	2.99E-3	3.44E-3	55	277.97	3.85E-2	4.56E-2	5.36E-2	6.28E-2
56	-93.26	1.90E-3	2.24E-3	2.60E-3	3.00E-3	56	284.37	3.73E-2	4.41E-2	5.20E-2	6.10E-2
57	-118.38	1.65E-3	1.96E-3	2.28E-3	2.65E-3	57	290.87	3.60E-2	4.27E-2	5.04E-2	5.93E-2
58	-145.52	1.44E-3	1.72E-3	2.01E-3	2.35E-3	58	297.46	3.48E-2	4.13E-2	4.89E-2	5.76E-2
59	-174.76	1.28E-3	1.53E-3	1.79E-3	2.10E-3	59	304.14	3.37E-2	4.00E-2	4.74E-2	5.60E-2
60	-206.23	1.14E-3	1.36E-3	1.61E-3	1.89E-3	60	310.90	3.26E-2	3.88E-2	4.60E-2	5.45E-2
61	-240.00	1.02E-3	1.22E-3	1.45E-3	1.71E-3	61	317.76	3.16E-2	3.76E-2	4.46E-2	5.30E-2
62	-276.23	9.20E-4	1.10E-3	1.31E-3	1.55E-3	62	324.71	3.06E-2	3.64E-2	4.33E-2	5.16E-2
63	-314.98	8.24E-4	9.96E-4	1.19E-3	1.42E-3	63	331.76	2.92E-2	3.53E-2	4.21E-2	5.02E-2
64	-356.42	7.47E-4	9.04E-4	1.08E-3	1.30E-3	64	338.89	2.83E-2	3.42E-2	4.09E-2	4.89E-2
65	-400.64	6.80E-4	8.23E-4	9.89E-4	1.19E-3	65	346.14	2.74E-2	3.31E-2	3.97E-2	4.76E-2
66	-447.79	6.21E-4	7.52E-4	9.06E-4	1.09E-3	66	353.48	2.66E-2	3.22E-2	3.86E-2	4.64E-2
67	-497.99	5.70E-4	6.89E-4	8.32E-4	1.01E-3	67	360.94	2.57E-2	3.12E-2	3.75E-2	4.52E-2
68	-551.40	5.24E-4	6.33E-4	7.67E-4	9.34E-4	68	368.49	2.49E-2	3.03E-2	3.64E-2	4.41E-2
69	-608.14	4.83E-4	5.83E-4	7.08E-4	8.66E-4	69	376.16	2.42E-2	2.94E-2	3.54E-2	4.30E-2
70	-668.42	4.47E-4	5.39E-4	6.55E-4	8.04E-4	70	383.92	2.35E-2	2.85E-2	3.44E-2	4.19E-2
71	-732.34	4.14E-4	4.99E-4	6.08E-4	7.49E-4	71	391.81	2.27E-2	2.77E-2	3.35E-2	4.08E-2
72	-800.11	3.84E-4	4.63E-4	5.65E-4	6.98E-4	72	399.80	2.21E-2	2.69E-2	3.26E-2	3.98E-2
73	-871.89	3.58E-4	4.30E-4	5.26E-4	6.53E-4	73	407.90	2.14E-2	2.61E-2	3.17E-2	3.89E-2
74	-947.87	3.33E-4	4.01E-4	4.91E-4	6.11E-4	74	416.12	2.08E-2	2.53E-2	3.08E-2	3.79E-2
75	-1028.24	3.10E-4	3.74E-4	4.59E-4	5.73E-4	75	424.46	2.02E-2	2.46E-2	3.00E-2	3.70E-2
76	-1113.21	2.89E-4	3.49E-4	4.29E-4	5.38E-4	76	432.89	1.96E-2	2.39E-2	2.92E-2	3.62E-2
77	-1202.98	2.70E-4	3.27E-4	4.02E-4	5.06E-4	77	441.47	1.90E-2	2.32E-2	2.84E-2	3.53E-2
78	-1297.78	2.53E-4	3.06E-4	3.77E-4	4.76E-4	78	450.15	1.84E-2	2.26E-2	2.77E-2	3.45E-2
79	-1397.83	2.37E-4	2.87E-4	3.55E-4	4.49E-4	79	458.97	1.79E-2	2.20E-2	2.70E-2	3.37E-2
80	-1503.42	2.22E-4	2.70E-4	3.34E-4	4.24E-4	80	467.86	1.74E-2	2.13E-2	2.63E-2	3.29E-2
81	-1614.77	2.08E-4	2.53E-4	3.15E-4	4.00E-4	81	476.87	1.69E-2	2.07E-2	2.56E-2	3.22E-2
82	-1732.15	1.95E-4	2.38E-4	2.97E-4	3.79E-4	82	486.00	1.64E-2	2.02E-2	2.49E-2	3.14E-2
83	-1855.82	1.83E-4	2.25E-4	2.80E-4	3.59E-4	83	495.27	1.59E-2	1.96E-2	2.43E-2	3.07E-2
84	-1986.05	1.72E-4	2.12E-4	2.65E-4	3.40E-4	84	504.69	1.54E-2	1.91E-2	2.37E-2	3.00E-2
85	-2123.24	1.62E-4	2.00E-4	2.50E-4	3.23E-4	85	514.20	1.50E-2	1.85E-2	2.31E-2	2.93E-2
86	-2268.00	1.53E-4	1.89E-4	2.37E-4	3.07E-4	86	523.44	1.46E-2	1.80E-2	2.25E-2	2.87E-2
87	-2420.08	1.44E-4	1.78E-4	2.25E-4	2.92E-4	87	533.11	1.42E-2	1.75E-2	2.19E-2	2.80E-2
88	-2580.20	1.36E-4	1.69E-4	2.13E-4	2.78E-4	88	542.78	1.37E-2	1.70E-2	2.14E-2	2.74E-2
89	-2748.62	1.28E-4	1.60E-4	2.02E-4	2.65E-4	89	552.60	1.33E-2	1.66E-2	2.08E-2	2.68E-2
90	-2925.98	1.21E-4	1.52E-4	1.92E-4	2.52E-4	90	562.29	1.30E-2	1.61E-2	2.03E-2	2.62E-2
91	-3112.31	1.15E-4	1.44E-4	1.83E-4	2.41E-4	91	572.29	1.26E-2	1.57E-2	1.98E-2	2.56E-2
92	-3308.70	1.08E-4	1.36E-4	1.74E-4	2.30E-4	92	581.90	1.22E-2	1.53E-2	1.93E-2	2.51E-2

TABLE 2. Collision Strengths as a Function of Scattered Electron Energy E'

See page 14 for Explanation of Tables

$B_1 - D_1$						$B_1 - E_1$					
Z	E_{if}	$E'=0.20$	$E'=0.42$	$E'=0.80$	$E'=1.40$	Z	E_{if}	$E'=0.20$	$E'=0.42$	$E'=0.80$	$E'=1.40$
26	117.62	2.09E-1	2.45E-1	2.82E-1	3.17E-1	26	112.08	1.55E-1	1.81E-1	2.07E-1	2.33E-1
27	125.14	1.93E-1	2.27E-1	2.61E-1	2.94E-1	27	118.38	1.43E-1	1.67E-1	1.91E-1	2.14E-1
28	133.02	1.79E-1	2.11E-1	2.42E-1	2.73E-1	28	124.81	1.31E-1	1.53E-1	1.75E-1	1.97E-1
29	141.29	1.67E-1	1.96E-1	2.25E-1	2.54E-1	29	131.38	1.20E-1	1.41E-1	1.61E-1	1.81E-1
30	150.00	1.55E-1	1.83E-1	2.10E-1	2.37E-1	30	138.07	1.11E-1	1.29E-1	1.48E-1	1.67E-1
31	159.16	1.45E-1	1.70E-1	1.96E-1	2.22E-1	31	144.88	1.01E-1	1.19E-1	1.36E-1	1.53E-1
32	168.83	1.36E-1	1.60E-1	1.84E-1	2.08E-1	32	151.79	9.30E-2	1.09E-1	1.25E-1	1.41E-1
33	179.03	1.27E-1	1.49E-1	1.73E-1	1.95E-1	33	158.79	8.51E-2	9.96E-2	1.14E-1	1.29E-1
34	189.80	1.20E-1	1.40E-1	1.62E-1	1.84E-1	34	165.86	7.79E-2	9.12E-2	1.05E-1	1.19E-1
35	201.19	1.12E-1	1.32E-1	1.53E-1	1.73E-1	35	173.00	7.11E-2	8.33E-2	9.58E-2	1.08E-1
36	213.24	1.07E-1	1.24E-1	1.43E-1	1.63E-1	36	180.19	6.56E-2	7.59E-2	8.74E-2	9.92E-2
37	225.99	1.00E-1	1.17E-1	1.35E-1	1.54E-1	37	187.43	5.99E-2	6.93E-2	7.99E-2	9.08E-2
38	239.49	9.47E-2	1.11E-1	1.28E-1	1.46E-1	38	194.69	5.47E-2	6.34E-2	7.31E-2	8.32E-2
39	253.78	8.94E-2	1.05E-1	1.21E-1	1.39E-1	39	201.99	5.00E-2	5.80E-2	6.69E-2	7.63E-2
40	268.93	8.45E-2	9.90E-2	1.15E-1	1.31E-1	40	209.32	4.58E-2	5.31E-2	6.14E-2	7.01E-2
41	284.97	7.99E-2	9.38E-2	1.09E-1	1.25E-1	41	216.66	4.20E-2	4.87E-2	5.64E-2	6.44E-2
42	301.97	7.57E-2	8.89E-2	1.03E-1	1.19E-1	42	224.04	3.86E-2	4.48E-2	5.19E-2	5.94E-2
43	319.97	7.17E-2	8.44E-2	9.81E-2	1.13E-1	43	231.44	3.55E-2	4.13E-2	4.78E-2	5.49E-2
44	339.05	6.81E-2	8.01E-2	9.33E-2	1.08E-1	44	238.87	3.27E-2	3.81E-2	4.42E-2	5.08E-2
45	359.26	6.47E-2	7.62E-2	8.88E-2	1.03E-1	45	246.33	3.03E-2	3.53E-2	4.10E-2	4.71E-2
46	380.66	6.15E-2	7.25E-2	8.46E-2	9.81E-2	46	253.83	2.80E-2	3.27E-2	3.81E-2	4.39E-2
47	403.32	5.86E-2	6.90E-2	8.06E-2	9.37E-2	47	261.37	2.61E-2	3.05E-2	3.55E-2	4.09E-2
48	427.30	5.59E-2	6.57E-2	7.69E-2	8.96E-2	48	268.95	2.43E-2	2.85E-2	3.31E-2	3.83E-2
49	452.69	5.34E-2	6.26E-2	7.34E-2	8.57E-2	49	276.58	2.27E-2	2.66E-2	3.10E-2	3.59E-2
50	479.55	5.11E-2	5.97E-2	7.01E-2	8.21E-2	50	284.26	2.13E-2	2.49E-2	2.91E-2	3.38E-2
51	507.96	4.86E-2	5.67E-2	6.69E-2	7.86E-2	51	292.00	1.99E-2	2.33E-2	2.73E-2	3.18E-2
52	538.00	4.66E-2	5.43E-2	6.41E-2	7.55E-2	52	299.79	1.88E-2	2.20E-2	2.58E-2	3.00E-2
53	569.76	4.43E-2	5.21E-2	6.15E-2	7.25E-2	53	307.66	1.77E-2	2.08E-2	2.43E-2	2.84E-2
54	603.31	4.20E-2	4.99E-2	5.89E-2	6.96E-2	54	315.60	1.66E-2	1.96E-2	2.30E-2	2.69E-2
55	638.75	3.99E-2	4.78E-2	5.65E-2	6.69E-2	55	323.61	1.58E-2	1.85E-2	2.18E-2	2.56E-2
56	676.17	3.80E-2	4.57E-2	5.42E-2	6.44E-2	56	331.69	1.49E-2	1.76E-2	2.07E-2	2.43E-2
57	715.68	3.64E-2	4.37E-2	5.21E-2	6.19E-2	57	339.86	1.42E-2	1.67E-2	1.97E-2	2.32E-2
58	757.36	3.48E-2	4.19E-2	5.00E-2	5.97E-2	58	348.11	1.35E-2	1.59E-2	1.87E-2	2.21E-2
59	801.33	3.34E-2	4.01E-2	4.80E-2	5.75E-2	59	356.46	1.28E-2	1.51E-2	1.79E-2	2.11E-2
60	847.68	3.21E-2	3.84E-2	4.61E-2	5.54E-2	60	364.89	1.22E-2	1.44E-2	1.70E-2	2.02E-2
61	896.55	3.08E-2	3.69E-2	4.44E-2	5.34E-2	61	373.43	1.16E-2	1.37E-2	1.63E-2	1.94E-2
62	948.02	2.96E-2	3.54E-2	4.27E-2	5.16E-2	62	382.05	1.11E-2	1.31E-2	1.56E-2	1.86E-2
63	1002.25	2.85E-2	3.41E-2	4.10E-2	4.96E-2	63	390.79	1.04E-2	1.25E-2	1.49E-2	1.79E-2
64	1059.33	2.73E-2	3.28E-2	3.95E-2	4.80E-2	64	399.63	9.99E-3	1.20E-2	1.43E-2	1.72E-2
65	1119.43	2.62E-2	3.16E-2	3.80E-2	4.63E-2	65	408.59	9.57E-3	1.15E-2	1.37E-2	1.65E-2
66	1182.66	2.51E-2	3.04E-2	3.67E-2	4.48E-2	66	417.66	9.17E-3	1.10E-2	1.32E-2	1.59E-2
67	1249.17	2.41E-2	2.92E-2	3.54E-2	4.33E-2	67	426.85	8.80E-3	1.06E-2	1.27E-2	1.54E-2
68	1319.12	2.31E-2	2.81E-2	3.41E-2	4.19E-2	68	436.17	8.45E-3	1.02E-2	1.22E-2	1.48E-2
69	1392.65	2.22E-2	2.71E-2	3.29E-2	4.06E-2	69	445.62	8.12E-3	9.78E-3	1.18E-2	1.43E-2
70	1469.92	2.14E-2	2.61E-2	3.18E-2	3.93E-2	70	455.19	7.81E-3	9.41E-3	1.14E-2	1.38E-2
71	1551.11	2.05E-2	2.51E-2	3.07E-2	3.81E-2	71	464.91	7.51E-3	9.06E-3	1.10E-2	1.34E-2
72	1636.38	1.97E-2	2.42E-2	2.97E-2	3.69E-2	72	474.75	7.23E-3	8.73E-3	1.06E-2	1.30E-2
73	1725.92	1.90E-2	2.33E-2	2.87E-2	3.58E-2	73	484.74	6.96E-3	8.41E-3	1.02E-2	1.25E-2
74	1819.93	1.83E-2	2.25E-2	2.77E-2	3.47E-2	74	494.87	6.71E-3	8.12E-3	9.87E-3	1.21E-2
75	1918.60	1.76E-2	2.17E-2	2.68E-2	3.36E-2	75	505.16	6.47E-3	7.83E-3	9.54E-3	1.18E-2
76	2022.11	1.70E-2	2.09E-2	2.59E-2	3.26E-2	76	515.58	6.24E-3	7.56E-3	9.22E-3	1.14E-2
77	2130.73	1.64E-2	2.02E-2	2.51E-2	3.17E-2	77	526.17	6.02E-3	7.30E-3	8.93E-3	1.11E-2
78	2244.64	1.58E-2	1.94E-2	2.43E-2	3.08E-2	78	536.91	5.81E-3	7.05E-3	8.64E-3	1.08E-2
79	2364.11	1.53E-2	1.88E-2	2.35E-2	2.99E-2	79	547.83	5.61E-3	6.82E-3	8.37E-3	1.05E-2
80	2489.34	1.48E-2	1.81E-2	2.27E-2	2.90E-2	80	558.87	5.42E-3	6.59E-3	8.11E-3	1.02E-2
81	2620.61	1.43E-2	1.75E-2	2.20E-2	2.82E-2	81	570.07	5.24E-3	6.38E-3	7.86E-3	9.88E-3
82	2758.20	1.38E-2	1.69E-2	2.13E-2	2.74E-2	82	581.45	5.06E-3	6.17E-3	7.62E-3	9.61E-3
83	2902.43	1.33E-2	1.63E-2	2.06E-2	2.66E-2	83	593.01	4.89E-3	5.97E-3	7.39E-3	9.35E-3
84	3053.59	1.29E-2	1.58E-2	2.00E-2	2.59E-2	84	604.79	4.73E-3	5.78E-3	7.16E-3	9.09E-3
85	3211.94	1.24E-2	1.52E-2	1.94E-2	2.51E-2	85	616.71	4.58E-3	5.60E-3	6.95E-3	8.85E-3
86	3377.43	1.20E-2	1.47E-2	1.88E-2	2.45E-2	86	628.43	4.43E-3	5.42E-3	6.75E-3	8.62E-3
87	3551.14	1.16E-2	1.43E-2	1.82E-2	2.38E-2	87	640.64	4.29E-3	5.25E-3	6.55E-3	8.39E-3
88	3733.00	1.12E-2	1.38E-2	1.76E-2	2.31E-2	88	652.93	4.15E-3	5.09E-3	6.36E-3	8.17E-3
89	3923.53	1.08E-2	1.33E-2	1.71E-2	2.25E-2	89	665.43	4.02E-3	4.93E-3	6.18E-3	7.96E-3
90	4122.84	1.04E-2	1.29E-2	1.66E-2	2.19E-2	90	677.89	3.89E-3	4.78E-3	6.00E-3	7.76E-3
91	4331.86	1.00E-2	1.25E-2	1.61E-2	2.13E-2	91	690.76	3.77E-3	4.63E-3	5.83E-3	7.56E-3
92	4550.23	9.67E-3	1.21E-2	1.56E-2	2.07E-2	92	703.29	3.65E-3	4.49E-3	5.66E-3	7.37E-3

TABLE 2. Collision Strengths as a Function of Scattered Electron Energy E'

See page 14 for Explanation of Tables

$B_1 - E_2$						$B_1 - F_1$					
Z	E_{if}	$E'=0.20$	$E'=0.42$	$E'=0.80$	$E'=1.40$	Z	E_{if}	$E'=0.20$	$E'=0.42$	$E'=0.80$	$E'=1.40$
26	148.79	6.77E-3	6.32E-3	6.40E-3	6.83E-3	26	104.37	2.69E-1	3.15E-1	3.60E-1	4.04E-1
27	156.70	7.47E-3	7.27E-3	7.58E-3	8.19E-3	27	109.41	2.50E-1	2.92E-1	3.34E-1	3.75E-1
28	164.87	8.32E-3	8.37E-3	8.92E-3	9.75E-3	28	114.48	2.32E-1	2.72E-1	3.11E-1	3.50E-1
29	173.33	9.31E-3	9.62E-3	1.04E-2	1.15E-2	29	119.58	2.17E-1	2.54E-1	2.91E-1	3.27E-1
30	182.13	1.04E-2	1.10E-2	1.21E-2	1.34E-2	30	124.71	2.03E-1	2.37E-1	2.72E-1	3.06E-1
31	191.32	1.16E-2	1.25E-2	1.38E-2	1.54E-2	31	129.88	1.90E-1	2.23E-1	2.55E-1	2.87E-1
32	200.93	1.29E-2	1.40E-2	1.57E-2	1.75E-2	32	135.07	1.79E-1	2.09E-1	2.40E-1	2.70E-1
33	211.04	1.42E-2	1.56E-2	1.76E-2	1.97E-2	33	140.31	1.68E-1	1.97E-1	2.26E-1	2.55E-1
34	221.68	1.54E-2	1.72E-2	1.94E-2	2.18E-2	34	145.58	1.58E-1	1.86E-1	2.13E-1	2.41E-1
35	232.92	1.66E-2	1.86E-2	2.12E-2	2.39E-2	35	150.89	1.50E-1	1.75E-1	2.01E-1	2.28E-1
36	244.80	1.78E-2	2.01E-2	2.27E-2	2.57E-2	36	156.24	1.42E-1	1.65E-1	1.90E-1	2.15E-1
37	257.40	1.88E-2	2.13E-2	2.42E-2	2.74E-2	37	161.64	1.34E-1	1.56E-1	1.80E-1	2.05E-1
38	270.76	1.96E-2	2.23E-2	2.54E-2	2.89E-2	38	167.08	1.27E-1	1.48E-1	1.71E-1	1.94E-1
39	284.93	2.03E-2	2.31E-2	2.64E-2	3.01E-2	39	172.56	1.21E-1	1.41E-1	1.63E-1	1.85E-1
40	299.98	2.08E-2	2.38E-2	2.72E-2	3.11E-2	40	178.09	1.15E-1	1.34E-1	1.55E-1	1.77E-1
41	315.96	2.11E-2	2.42E-2	2.78E-2	3.18E-2	41	183.67	1.09E-1	1.28E-1	1.48E-1	1.69E-1
42	332.92	2.13E-2	2.45E-2	2.81E-2	3.22E-2	42	189.30	1.04E-1	1.22E-1	1.41E-1	1.61E-1
43	350.93	2.13E-2	2.46E-2	2.83E-2	3.25E-2	43	194.99	9.92E-2	1.16E-1	1.35E-1	1.54E-1
44	370.03	2.13E-2	2.46E-2	2.83E-2	3.26E-2	44	200.73	9.47E-2	1.11E-1	1.29E-1	1.48E-1
45	390.30	2.11E-2	2.44E-2	2.82E-2	3.25E-2	45	206.52	9.04E-2	1.06E-1	1.23E-1	1.42E-1
46	411.78	2.09E-2	2.42E-2	2.80E-2	3.23E-2	46	212.38	8.64E-2	1.01E-1	1.18E-1	1.36E-1
47	434.55	2.06E-2	2.38E-2	2.76E-2	3.20E-2	47	218.29	8.26E-2	9.72E-2	1.13E-1	1.31E-1
48	458.68	2.03E-2	2.34E-2	2.72E-2	3.16E-2	48	224.26	7.90E-2	9.32E-2	1.09E-1	1.25E-1
49	484.23	1.99E-2	2.29E-2	2.67E-2	3.11E-2	49	230.30	7.56E-2	8.94E-2	1.04E-1	1.21E-1
50	511.27	1.95E-2	2.24E-2	2.61E-2	3.05E-2	50	236.41	7.29E-2	8.60E-2	1.00E-1	1.16E-1
51	539.88	1.90E-2	2.18E-2	2.55E-2	2.99E-2	51	242.59	6.98E-2	8.25E-2	9.65E-2	1.12E-1
52	570.14	1.86E-2	2.13E-2	2.50E-2	2.93E-2	52	248.83	6.72E-2	7.94E-2	9.30E-2	1.08E-1
53	602.13	1.80E-2	2.08E-2	2.44E-2	2.87E-2	53	255.16	6.42E-2	7.62E-2	8.95E-2	1.04E-1
54	635.93	1.73E-2	2.03E-2	2.38E-2	2.80E-2	54	261.55	6.19E-2	7.34E-2	8.62E-2	1.01E-1
55	671.63	1.67E-2	1.97E-2	2.31E-2	2.73E-2	55	268.03	5.97E-2	7.07E-2	8.32E-2	9.74E-2
56	709.32	1.61E-2	1.91E-2	2.25E-2	2.67E-2	56	274.58	5.75E-2	6.82E-2	8.03E-2	9.42E-2
57	749.11	1.56E-2	1.85E-2	2.19E-2	2.60E-2	57	281.22	5.52E-2	6.57E-2	7.75E-2	9.12E-2
58	791.09	1.51E-2	1.79E-2	2.13E-2	2.53E-2	58	287.95	5.32E-2	6.33E-2	7.49E-2	8.83E-2
59	835.35	1.47E-2	1.73E-2	2.06E-2	2.46E-2	59	294.77	5.14E-2	6.11E-2	7.23E-2	8.55E-2
60	882.02	1.42E-2	1.68E-2	2.00E-2	2.40E-2	60	301.68	4.96E-2	5.90E-2	6.99E-2	8.29E-2
61	931.20	1.38E-2	1.62E-2	1.94E-2	2.33E-2	61	308.69	4.78E-2	5.70E-2	6.77E-2	8.04E-2
62	982.98	1.33E-2	1.57E-2	1.88E-2	2.27E-2	62	315.77	4.62E-2	5.51E-2	6.55E-2	7.80E-2
63	1037.54	1.30E-2	1.53E-2	1.82E-2	2.20E-2	63	322.98	4.40E-2	5.32E-2	6.35E-2	7.57E-2
64	1094.94	1.25E-2	1.48E-2	1.77E-2	2.14E-2	64	330.27	4.25E-2	5.14E-2	6.15E-2	7.35E-2
65	1155.37	1.21E-2	1.43E-2	1.71E-2	2.08E-2	65	337.68	4.11E-2	4.97E-2	5.95E-2	7.14E-2
66	1218.93	1.16E-2	1.39E-2	1.66E-2	2.03E-2	66	345.19	3.97E-2	4.81E-2	5.77E-2	6.94E-2
67	1285.78	1.12E-2	1.34E-2	1.61E-2	1.97E-2	67	352.81	3.84E-2	4.66E-2	5.60E-2	6.75E-2
68	1356.06	1.08E-2	1.30E-2	1.56E-2	1.92E-2	68	360.56	3.71E-2	4.51E-2	5.43E-2	6.56E-2
69	1429.93	1.05E-2	1.26E-2	1.52E-2	1.86E-2	69	368.42	3.59E-2	4.37E-2	5.26E-2	6.39E-2
70	1507.53	1.01E-2	1.21E-2	1.47E-2	1.81E-2	70	376.39	3.48E-2	4.23E-2	5.11E-2	6.21E-2
71	1589.06	9.75E-3	1.17E-2	1.43E-2	1.76E-2	71	384.49	3.37E-2	4.10E-2	4.96E-2	6.05E-2
72	1674.66	9.42E-3	1.14E-2	1.38E-2	1.71E-2	72	392.71	3.26E-2	3.97E-2	4.81E-2	5.89E-2
73	1764.53	9.10E-3	1.10E-2	1.34E-2	1.67E-2	73	401.07	3.16E-2	3.85E-2	4.68E-2	5.74E-2
74	1858.86	8.79E-3	1.06E-2	1.30E-2	1.62E-2	74	409.55	3.06E-2	3.73E-2	4.54E-2	5.59E-2
75	1957.86	8.50E-3	1.03E-2	1.26E-2	1.58E-2	75	418.18	2.96E-2	3.62E-2	4.41E-2	5.45E-2
76	2061.69	8.23E-3	9.95E-3	1.22E-2	1.54E-2	76	426.91	2.87E-2	3.51E-2	4.29E-2	5.31E-2
77	2170.62	7.96E-3	9.62E-3	1.19E-2	1.50E-2	77	435.81	2.78E-2	3.40E-2	4.17E-2	5.18E-2
78	2284.85	7.71E-3	9.31E-3	1.15E-2	1.46E-2	78	444.84	2.69E-2	3.30E-2	4.05E-2	5.05E-2
79	2404.63	7.46E-3	9.01E-3	1.12E-2	1.42E-2	79	454.02	2.61E-2	3.21E-2	3.94E-2	4.92E-2
80	2530.15	7.23E-3	8.72E-3	1.09E-2	1.38E-2	80	463.32	2.53E-2	3.11E-2	3.83E-2	4.80E-2
81	2661.72	7.00E-3	8.44E-3	1.05E-2	1.35E-2	81	472.75	2.45E-2	3.02E-2	3.73E-2	4.68E-2
82	2799.59	6.78E-3	8.17E-3	1.02E-2	1.31E-2	82	482.34	2.38E-2	2.93E-2	3.63E-2	4.57E-2
83	2944.10	6.57E-3	7.91E-3	9.92E-3	1.28E-2	83	492.10	2.31E-2	2.85E-2	3.53E-2	4.46E-2
84	3095.53	6.36E-3	7.66E-3	9.63E-3	1.24E-2	84	502.04	2.24E-2	2.76E-2	3.43E-2	4.35E-2
85	3254.14	6.16E-3	7.42E-3	9.35E-3	1.21E-2	85	512.10	2.17E-2	2.68E-2	3.34E-2	4.25E-2
86	3419.88	5.96E-3	7.19E-3	9.07E-3	1.18E-2	86	521.95	2.11E-2	2.61E-2	3.25E-2	4.15E-2
87	3593.83	5.76E-3	6.96E-3	8.81E-3	1.15E-2	87	532.26	2.04E-2	2.53E-2	3.16E-2	4.05E-2
88	3775.90	5.57E-3	6.75E-3	8.55E-3	1.12E-2	88	542.62	1.98E-2	2.46E-2	3.08E-2	3.96E-2
89	3966.65	5.39E-3	6.54E-3	8.30E-3	1.09E-2	89	553.18	1.92E-2	2.39E-2	3.00E-2	3.86E-2
90	4166.16	5.21E-3	6.35E-3	8.06E-3	1.06E-2	90	563.66	1.86E-2	2.32E-2	2.92E-2	3.77E-2
91	4375.36	5.03E-3	6.15E-3	7.83E-3	1.04E-2	91	574.52	1.81E-2	2.25E-2	2.84E-2	3.69E-2
92	4593.90	4.86E-3	5.97E-3	7.60E-3	1.01E-2	92	585.03	1.76E-2	2.19E-2	2.77E-2	3.60E-2

TABLE 2. Collision Strengths as a Function of Scattered Electron Energy E'

See page 14 for Explanation of Tables

$C_1 - E_1$						$C_1 - E_2$					
Z	E_{if}	$E'=0.20$	$E'=0.42$	$E'=0.80$	$E'=1.40$	Z	E_{if}	$E'=0.20$	$E'=0.42$	$E'=0.80$	$E'=1.40$
26	123.13	2.82E-1	3.29E-1	3.79E-1	4.26E-1	26	159.84	4.95E-2	5.62E-2	6.41E-2	7.21E-2
27	131.67	2.66E-1	3.11E-1	3.58E-1	4.03E-1	27	169.99	4.90E-2	5.59E-2	6.39E-2	7.21E-2
28	140.67	2.53E-1	2.96E-1	3.40E-1	3.84E-1	28	180.73	4.76E-2	5.45E-2	6.24E-2	7.05E-2
29	150.18	2.42E-1	2.83E-1	3.26E-1	3.67E-1	29	192.12	4.54E-2	5.21E-2	5.97E-2	6.75E-2
30	160.20	2.33E-1	2.71E-1	3.13E-1	3.53E-1	30	204.26	4.24E-2	4.88E-2	5.61E-2	6.35E-2
31	170.77	2.24E-1	2.62E-1	3.01E-1	3.41E-1	31	217.21	3.89E-2	4.49E-2	5.16E-2	5.85E-2
32	181.91	2.16E-1	2.53E-1	2.92E-1	3.30E-1	32	231.05	3.51E-2	4.06E-2	4.67E-2	5.30E-2
33	193.64	2.10E-1	2.45E-1	2.83E-1	3.20E-1	33	245.89	3.12E-2	3.61E-2	4.16E-2	4.73E-2
34	205.99	2.03E-1	2.37E-1	2.74E-1	3.12E-1	34	261.81	2.72E-2	3.16E-2	3.65E-2	4.16E-2
35	218.99	1.97E-1	2.30E-1	2.66E-1	3.03E-1	35	278.90	2.35E-2	2.73E-2	3.15E-2	3.60E-2
36	232.65	1.92E-1	2.24E-1	2.58E-1	2.94E-1	36	297.27	2.00E-2	2.34E-2	2.69E-2	3.07E-2
37	247.03	1.86E-1	2.17E-1	2.50E-1	2.85E-1	37	317.00	1.69E-2	1.98E-2	2.28E-2	2.60E-2
38	262.15	1.80E-1	2.10E-1	2.43E-1	2.77E-1	38	338.21	1.41E-2	1.66E-2	1.91E-2	2.19E-2
39	278.05	1.74E-1	2.03E-1	2.35E-1	2.69E-1	39	360.99	1.17E-2	1.38E-2	1.59E-2	1.82E-2
40	294.79	1.68E-1	1.96E-1	2.27E-1	2.61E-1	40	385.45	9.67E-3	1.14E-2	1.32E-2	1.51E-2
41	312.40	1.62E-1	1.90E-1	2.20E-1	2.52E-1	41	411.70	7.97E-3	9.38E-3	1.09E-2	1.25E-2
42	330.94	1.56E-1	1.83E-1	2.12E-1	2.44E-1	42	439.83	6.55E-3	7.71E-3	8.97E-3	1.03E-2
43	350.48	1.50E-1	1.76E-1	2.05E-1	2.36E-1	43	469.96	5.38E-3	6.33E-3	7.38E-3	8.53E-3
44	371.06	1.44E-1	1.70E-1	1.97E-1	2.28E-1	44	502.22	4.42E-3	5.20E-3	6.07E-3	7.03E-3
45	392.75	1.39E-1	1.63E-1	1.90E-1	2.20E-1	45	536.71	3.63E-3	4.27E-3	4.99E-3	5.80E-3
46	415.61	1.34E-1	1.57E-1	1.83E-1	2.13E-1	46	573.56	2.99E-3	3.51E-3	4.11E-3	4.79E-3
47	439.71	1.29E-1	1.51E-1	1.76E-1	2.05E-1	47	612.90	2.46E-3	2.89E-3	3.39E-3	3.96E-3
48	465.13	1.24E-1	1.45E-1	1.70E-1	1.98E-1	48	654.86	2.03E-3	2.38E-3	2.81E-3	3.28E-3
49	491.93	1.19E-1	1.40E-1	1.63E-1	1.91E-1	49	699.58	1.68E-3	1.97E-3	2.32E-3	2.73E-3
50	520.19	1.15E-1	1.34E-1	1.57E-1	1.84E-1	50	747.20	1.40E-3	1.63E-3	1.93E-3	2.27E-3
51	549.99	1.10E-1	1.28E-1	1.51E-1	1.78E-1	51	797.87	1.16E-3	1.36E-3	1.61E-3	1.89E-3
52	581.41	1.06E-1	1.23E-1	1.46E-1	1.71E-1	52	851.75	9.66E-4	1.13E-3	1.34E-3	1.59E-3
53	614.54	1.01E-1	1.19E-1	1.40E-1	1.66E-1	53	909.00	8.05E-4	9.46E-4	1.12E-3	1.33E-3
54	649.45	9.68E-2	1.15E-1	1.35E-1	1.60E-1	54	969.78	6.73E-4	7.93E-4	9.42E-4	1.12E-3
55	686.26	9.24E-2	1.10E-1	1.30E-1	1.54E-1	55	1034.28	5.63E-4	6.67E-4	7.93E-4	9.45E-4
56	725.03	8.84E-2	1.06E-1	1.26E-1	1.49E-1	56	1102.67	4.73E-4	5.62E-4	6.69E-4	8.00E-4
57	765.89	8.48E-2	1.02E-1	1.21E-1	1.44E-1	57	1175.14	3.99E-4	4.75E-4	5.66E-4	6.79E-4
58	808.92	8.16E-2	9.78E-2	1.17E-1	1.39E-1	58	1251.90	3.37E-4	4.02E-4	4.80E-4	5.77E-4
59	854.24	7.86E-2	9.40E-2	1.12E-1	1.35E-1	59	1333.14	2.86E-4	3.42E-4	4.08E-4	4.93E-4
60	901.94	7.57E-2	9.04E-2	1.08E-1	1.30E-1	60	1419.07	2.44E-4	2.91E-4	3.48E-4	4.21E-4
61	952.16	7.29E-2	8.70E-2	1.05E-1	1.26E-1	61	1509.92	2.08E-4	2.48E-4	2.98E-4	3.61E-4
62	1004.98	7.02E-2	8.37E-2	1.01E-1	1.22E-1	62	1605.91	1.78E-4	2.12E-4	2.55E-4	3.10E-4
63	1060.55	6.78E-2	8.11E-2	9.72E-2	1.18E-1	63	1707.30	1.51E-4	1.81E-4	2.20E-4	2.67E-4
64	1118.98	6.51E-2	7.81E-2	9.38E-2	1.14E-1	64	1814.30	1.30E-4	1.56E-4	1.89E-4	2.31E-4
65	1180.44	6.26E-2	7.53E-2	9.06E-2	1.10E-1	65	1927.22	1.12E-4	1.34E-4	1.63E-4	2.00E-4
66	1245.02	6.02E-2	7.26E-2	8.76E-2	1.07E-1	66	2046.29	9.66E-5	1.15E-4	1.41E-4	1.73E-4
67	1312.89	5.78E-2	7.00E-2	8.46E-2	1.04E-1	67	2171.81	8.35E-5	9.95E-5	1.22E-4	1.50E-4
68	1384.19	5.56E-2	6.75E-2	8.18E-2	1.01E-1	68	2304.08	7.23E-5	8.61E-5	1.06E-4	1.31E-4
69	1459.08	5.35E-2	6.51E-2	7.91E-2	9.75E-2	69	2443.39	6.26E-5	7.46E-5	9.17E-5	1.14E-4
70	1537.71	5.15E-2	6.28E-2	7.65E-2	9.45E-2	70	2590.05	5.43E-5	6.48E-5	7.98E-5	9.95E-5
71	1620.26	4.96E-2	6.06E-2	7.40E-2	9.17E-2	71	2744.41	4.71E-5	5.65E-5	6.96E-5	8.70E-5
72	1706.89	4.78E-2	5.85E-2	7.16E-2	8.90E-2	72	2906.80	4.09E-5	4.92E-5	6.07E-5	7.63E-5
73	1797.80	4.61E-2	5.64E-2	6.93E-2	8.64E-2	73	3077.60	3.56E-5	4.30E-5	5.31E-5	6.69E-5
74	1893.17	4.44E-2	5.45E-2	6.71E-2	8.39E-2	74	3257.16	3.10E-5	3.76E-5	4.65E-5	5.88E-5
75	1993.21	4.28E-2	5.26E-2	6.50E-2	8.15E-2	75	3445.90	2.71E-5	3.30E-5	4.08E-5	5.18E-5
76	2098.08	4.14E-2	5.07E-2	6.29E-2	7.92E-2	76	3644.19	2.37E-5	2.89E-5	3.59E-5	4.56E-5
77	2208.06	4.00E-2	4.90E-2	6.09E-2	7.69E-2	77	3852.51	2.08E-5	2.54E-5	3.16E-5	4.03E-5
78	2323.33	3.86E-2	4.73E-2	5.90E-2	7.48E-2	78	4071.27	1.83E-5	2.23E-5	2.78E-5	3.56E-5
79	2444.16	3.73E-2	4.57E-2	5.72E-2	7.27E-2	79	4300.96	1.61E-5	1.96E-5	2.46E-5	3.15E-5
80	2570.74	3.61E-2	4.42E-2	5.54E-2	7.07E-2	80	4542.03	1.42E-5	1.73E-5	2.17E-5	2.79E-5
81	2703.36	3.49E-2	4.27E-2	5.37E-2	6.88E-2	81	4795.00	1.26E-5	1.52E-5	1.92E-5	2.48E-5
82	2842.30	3.38E-2	4.13E-2	5.20E-2	6.69E-2	82	5060.44	1.11E-5	1.34E-5	1.70E-5	2.20E-5
83	2987.85	3.27E-2	3.99E-2	5.05E-2	6.50E-2	83	5338.94	9.77E-6	1.19E-5	1.51E-5	1.96E-5
84	3140.34	3.16E-2	3.86E-2	4.89E-2	6.33E-2	84	5631.08	8.61E-6	1.05E-5	1.34E-5	1.74E-5
85	3300.00	3.06E-2	3.73E-2	4.74E-2	6.16E-2	85	5937.43	7.60E-6	9.30E-6	1.19E-5	1.55E-5
86	3466.79	2.95E-2	3.62E-2	4.60E-2	5.99E-2	86	6258.23	6.72E-6	8.25E-6	1.05E-5	1.38E-5
87	3641.78	2.85E-2	3.50E-2	4.46E-2	5.83E-2	87	6594.97	5.96E-6	7.32E-6	9.37E-6	1.24E-5
88	3824.90	2.76E-2	3.39E-2	4.33E-2	5.68E-2	88	6947.88	5.29E-6	6.51E-6	8.34E-6	1.10E-5
89	4016.67	2.66E-2	3.28E-2	4.20E-2	5.53E-2	89	7317.89	4.70E-6	5.79E-6	7.42E-6	9.86E-6
90	4217.21	2.57E-2	3.18E-2	4.07E-2	5.38E-2	90	7705.47	4.18E-6	5.15E-6	6.61E-6	8.82E-6
91	4427.42	2.48E-2	3.08E-2	3.95E-2	5.24E-2	91	8112.02	3.72E-6	4.58E-6	5.90E-6	7.90E-6
92	4646.95	2.39E-2	2.99E-2	3.83E-2	5.10E-2	92	8537.56	3.30E-6	4.07E-6	5.27E-6	7.07E-6

TABLE 2. Collision Strengths as a Function of Scattered Electron Energy E'

See page 14 for Explanation of Tables

$C_2 - E_1$						$C_2 - E_2$					
Z	E_{if}	$E'=0.20$	$E'=0.42$	$E'=0.80$	$E'=1.40$	Z	E_{if}	$E'=0.20$	$E'=0.42$	$E'=0.80$	$E'=1.40$
26	102.00	4.13E-3	2.20E-3	1.04E-3	5.04E-4	26	138.71	9.15E-1	1.07E+0	1.24E+0	1.39E+0
27	108.02	4.01E-3	2.33E-3	1.34E-3	9.12E-4	27	146.34	8.40E-1	9.82E-1	1.13E+0	1.28E+0
28	114.18	4.28E-3	2.89E-3	2.12E-3	1.86E-3	28	154.23	7.72E-1	9.03E-1	1.04E+0	1.18E+0
29	120.48	5.03E-3	3.99E-3	3.51E-3	3.47E-3	29	162.43	7.11E-1	8.32E-1	9.61E-1	1.09E+0
30	126.90	6.32E-3	5.70E-3	5.58E-3	5.86E-3	30	170.96	6.56E-1	7.67E-1	8.87E-1	1.00E+0
31	133.44	8.18E-3	8.06E-3	8.39E-3	9.07E-3	31	179.88	6.06E-1	7.09E-1	8.19E-1	9.28E-1
32	140.09	1.06E-2	1.10E-2	1.19E-2	1.31E-2	32	189.23	5.60E-1	6.55E-1	7.57E-1	8.58E-1
33	146.83	1.35E-2	1.46E-2	1.61E-2	1.79E-2	33	199.08	5.17E-1	6.05E-1	7.01E-1	7.95E-1
34	153.64	1.68E-2	1.86E-2	2.08E-2	2.33E-2	34	209.46	4.78E-1	5.60E-1	6.48E-1	7.37E-1
35	160.53	2.03E-2	2.29E-2	2.58E-2	2.90E-2	35	220.44	4.42E-1	5.18E-1	6.00E-1	6.83E-1
36	167.46	2.42E-2	2.72E-2	3.09E-2	3.49E-2	36	232.07	4.11E-1	4.80E-1	5.54E-1	6.32E-1
37	174.44	2.78E-2	3.16E-2	3.61E-2	4.08E-2	37	244.41	3.80E-1	4.45E-1	5.13E-1	5.86E-1
38	181.46	3.13E-2	3.58E-2	4.10E-2	4.65E-2	38	257.52	3.52E-1	4.12E-1	4.76E-1	5.44E-1
39	188.50	3.46E-2	3.97E-2	4.55E-2	5.17E-2	39	271.44	3.26E-1	3.82E-1	4.42E-1	5.06E-1
40	195.58	3.74E-2	4.31E-2	4.96E-2	5.65E-2	40	286.24	3.02E-1	3.54E-1	4.10E-1	4.71E-1
41	202.68	3.99E-2	4.61E-2	5.32E-2	6.07E-2	41	301.98	2.80E-1	3.29E-1	3.82E-1	4.39E-1
42	209.81	4.20E-2	4.87E-2	5.62E-2	6.42E-2	42	318.70	2.61E-1	3.06E-1	3.56E-1	4.09E-1
43	216.97	4.37E-2	5.07E-2	5.87E-2	6.72E-2	43	336.46	2.43E-1	2.85E-1	3.32E-1	3.83E-1
44	224.16	4.50E-2	5.23E-2	6.07E-2	6.96E-2	44	355.33	2.27E-1	2.66E-1	3.10E-1	3.58E-1
45	231.40	4.59E-2	5.36E-2	6.21E-2	7.14E-2	45	375.36	2.12E-1	2.49E-1	2.90E-1	3.36E-1
46	238.66	4.66E-2	5.44E-2	6.32E-2	7.28E-2	46	396.62	1.98E-1	2.33E-1	2.72E-1	3.16E-1
47	245.98	4.69E-2	5.49E-2	6.39E-2	7.37E-2	47	419.17	1.86E-1	2.19E-1	2.56E-1	2.97E-1
48	253.34	4.70E-2	5.51E-2	6.42E-2	7.42E-2	48	443.07	1.75E-1	2.05E-1	2.40E-1	2.80E-1
49	260.75	4.69E-2	5.52E-2	6.43E-2	7.44E-2	49	468.40	1.65E-1	1.93E-1	2.26E-1	2.64E-1
50	268.22	4.67E-2	5.49E-2	6.41E-2	7.44E-2	50	495.23	1.56E-1	1.82E-1	2.13E-1	2.50E-1
51	275.76	4.62E-2	5.43E-2	6.36E-2	7.40E-2	51	523.64	1.47E-1	1.71E-1	2.01E-1	2.37E-1
52	283.35	4.58E-2	5.39E-2	6.31E-2	7.35E-2	52	553.69	1.39E-1	1.62E-1	1.91E-1	2.25E-1
53	291.03	4.50E-2	5.32E-2	6.24E-2	7.29E-2	53	585.49	1.31E-1	1.54E-1	1.81E-1	2.13E-1
54	298.77	4.43E-2	5.23E-2	6.15E-2	7.20E-2	54	619.10	1.23E-1	1.46E-1	1.72E-1	2.03E-1
55	306.60	4.36E-2	5.15E-2	6.06E-2	7.11E-2	55	654.63	1.16E-1	1.38E-1	1.63E-1	1.94E-1
56	314.51	4.28E-2	5.06E-2	5.97E-2	7.01E-2	56	692.14	1.09E-1	1.31E-1	1.56E-1	1.85E-1
57	322.51	4.20E-2	4.97E-2	5.86E-2	6.90E-2	57	731.76	1.04E-1	1.24E-1	1.48E-1	1.76E-1
58	330.60	4.10E-2	4.86E-2	5.75E-2	6.79E-2	58	773.58	9.87E-2	1.18E-1	1.41E-1	1.69E-1
59	338.79	4.01E-2	4.76E-2	5.64E-2	6.68E-2	59	817.69	9.41E-2	1.13E-1	1.35E-1	1.61E-1
60	347.08	3.93E-2	4.66E-2	5.53E-2	6.56E-2	60	864.21	8.98E-2	1.07E-1	1.29E-1	1.54E-1
61	355.48	3.83E-2	4.55E-2	5.41E-2	6.44E-2	61	913.24	8.57E-2	1.02E-1	1.23E-1	1.48E-1
62	363.97	3.74E-2	4.45E-2	5.29E-2	6.31E-2	62	964.90	8.18E-2	9.77E-2	1.18E-1	1.42E-1
63	372.59	3.59E-2	4.33E-2	5.18E-2	6.20E-2	63	1019.33	7.84E-2	9.37E-2	1.12E-1	1.36E-1
64	381.31	3.50E-2	4.23E-2	5.06E-2	6.07E-2	64	1076.63	7.48E-2	8.97E-2	1.08E-1	1.31E-1
65	390.17	3.41E-2	4.13E-2	4.95E-2	5.95E-2	65	1136.95	7.14E-2	8.59E-2	1.03E-1	1.26E-1
66	399.14	3.33E-2	4.02E-2	4.83E-2	5.83E-2	66	1200.41	6.82E-2	8.22E-2	9.92E-2	1.21E-1
67	408.24	3.24E-2	3.92E-2	4.72E-2	5.71E-2	67	1267.17	6.52E-2	7.88E-2	9.53E-2	1.17E-1
68	417.48	3.16E-2	3.82E-2	4.61E-2	5.59E-2	68	1337.37	6.23E-2	7.56E-2	9.16E-2	1.12E-1
69	426.87	3.07E-2	3.73E-2	4.50E-2	5.47E-2	69	1411.17	5.96E-2	7.25E-2	8.81E-2	1.08E-1
70	436.37	2.99E-2	3.63E-2	4.40E-2	5.36E-2	70	1488.71	5.71E-2	6.96E-2	8.48E-2	1.05E-1
71	446.04	2.91E-2	3.54E-2	4.29E-2	5.25E-2	71	1570.19	5.47E-2	6.68E-2	8.16E-2	1.01E-1
72	455.84	2.83E-2	3.45E-2	4.19E-2	5.14E-2	72	1655.75	5.25E-2	6.42E-2	7.86E-2	9.77E-2
73	465.81	2.76E-2	3.36E-2	4.09E-2	5.03E-2	73	1745.60	5.04E-2	6.17E-2	7.58E-2	9.45E-2
74	475.92	2.68E-2	3.27E-2	3.99E-2	4.92E-2	74	1839.91	4.84E-2	5.93E-2	7.31E-2	9.13E-2
75	486.20	2.61E-2	3.19E-2	3.89E-2	4.81E-2	75	1938.90	4.65E-2	5.70E-2	7.05E-2	8.84E-2
76	496.62	2.54E-2	3.10E-2	3.80E-2	4.71E-2	76	2042.73	4.48E-2	5.49E-2	6.80E-2	8.56E-2
77	507.24	2.47E-2	3.02E-2	3.71E-2	4.61E-2	77	2151.69	4.31E-2	5.28E-2	6.56E-2	8.29E-2
78	518.01	2.40E-2	2.94E-2	3.62E-2	4.51E-2	78	2265.94	4.15E-2	5.08E-2	6.34E-2	8.03E-2
79	528.96	2.34E-2	2.86E-2	3.53E-2	4.41E-2	79	2385.76	4.00E-2	4.90E-2	6.12E-2	7.78E-2
80	540.06	2.27E-2	2.79E-2	3.44E-2	4.32E-2	80	2511.34	3.86E-2	4.72E-2	5.91E-2	7.54E-2
81	551.32	2.21E-2	2.71E-2	3.36E-2	4.23E-2	81	2642.96	3.72E-2	4.54E-2	5.72E-2	7.32E-2
82	562.77	2.15E-2	2.64E-2	3.27E-2	4.14E-2	82	2780.92	3.59E-2	4.38E-2	5.53E-2	7.10E-2
83	574.43	2.09E-2	2.57E-2	3.20E-2	4.05E-2	83	2925.51	3.46E-2	4.23E-2	5.34E-2	6.89E-2
84	586.31	2.03E-2	2.50E-2	3.12E-2	3.96E-2	84	3077.05	3.34E-2	4.08E-2	5.17E-2	6.68E-2
85	598.34	1.98E-2	2.44E-2	3.04E-2	3.88E-2	85	3235.77	3.22E-2	3.94E-2	5.00E-2	6.49E-2
86	610.20	1.92E-2	2.37E-2	2.97E-2	3.79E-2	86	3401.64	3.11E-2	3.80E-2	4.84E-2	6.30E-2
87	622.55	1.87E-2	2.31E-2	2.89E-2	3.71E-2	87	3575.74	3.00E-2	3.67E-2	4.68E-2	6.12E-2
88	634.99	1.81E-2	2.25E-2	2.82E-2	3.63E-2	88	3757.97	2.89E-2	3.55E-2	4.53E-2	5.95E-2
89	647.67	1.76E-2	2.19E-2	2.75E-2	3.55E-2	89	3948.89	2.78E-2	3.43E-2	4.39E-2	5.78E-2
90	660.32	1.71E-2	2.13E-2	2.68E-2	3.48E-2	90	4148.58	2.68E-2	3.32E-2	4.25E-2	5.61E-2
91	673.39	1.67E-2	2.07E-2	2.62E-2	3.40E-2	91	4357.99	2.58E-2	3.21E-2	4.12E-2	5.46E-2
92	686.14	1.62E-2	2.02E-2	2.55E-2	3.33E-2	92	4576.74	2.49E-2	3.11E-2	3.99E-2	5.31E-2

TABLE 2. Collision Strengths as a Function of Scattered Electron Energy E'

See page 14 for Explanation of Tables

$C_1 - F_1$						$C_2 - F_1$					
Z	E_{if}	$E'=0.20$	$E'=0.42$	$E'=0.80$	$E'=1.40$	Z	E_{if}	$E'=0.20$	$E'=0.42$	$E'=0.80$	$E'=1.40$
26	115.42	7.17E-1	8.38E-1	9.61E-1	1.08E+0	26	94.29	8.21E-2	9.32E-2	1.05E-1	1.17E-1
27	122.70	6.54E-1	7.64E-1	8.77E-1	9.86E-1	27	99.05	8.62E-2	9.83E-2	1.11E-1	1.24E-1
28	130.34	5.98E-1	6.99E-1	8.02E-1	9.02E-1	28	103.85	8.95E-2	1.02E-1	1.16E-1	1.30E-1
29	138.38	5.48E-1	6.40E-1	7.35E-1	8.28E-1	29	108.68	9.21E-2	1.06E-1	1.20E-1	1.34E-1
30	146.84	5.03E-1	5.88E-1	6.75E-1	7.61E-1	30	113.54	9.40E-2	1.08E-1	1.23E-1	1.38E-1
31	155.77	4.63E-1	5.41E-1	6.22E-1	7.02E-1	31	118.44	9.51E-2	1.10E-1	1.25E-1	1.40E-1
32	165.20	4.27E-1	4.99E-1	5.74E-1	6.49E-1	32	123.38	9.56E-2	1.11E-1	1.26E-1	1.41E-1
33	175.16	3.95E-1	4.62E-1	5.32E-1	6.01E-1	33	128.35	9.56E-2	1.11E-1	1.26E-1	1.42E-1
34	185.71	3.66E-1	4.28E-1	4.93E-1	5.59E-1	34	133.36	9.51E-2	1.10E-1	1.26E-1	1.42E-1
35	196.88	3.40E-1	3.97E-1	4.59E-1	5.21E-1	35	138.42	9.41E-2	1.09E-1	1.25E-1	1.41E-1
36	208.71	3.19E-1	3.70E-1	4.26E-1	4.84E-1	36	143.51	9.27E-2	1.07E-1	1.23E-1	1.39E-1
37	221.24	2.97E-1	3.45E-1	3.98E-1	4.53E-1	37	148.65	9.12E-2	1.06E-1	1.21E-1	1.37E-1
38	234.53	2.77E-1	3.22E-1	3.72E-1	4.24E-1	38	153.84	8.94E-2	1.04E-1	1.19E-1	1.35E-1
39	248.62	2.59E-1	3.02E-1	3.49E-1	3.98E-1	39	159.07	8.74E-2	1.01E-1	1.17E-1	1.33E-1
40	263.56	2.43E-1	2.83E-1	3.27E-1	3.75E-1	40	164.36	8.53E-2	9.93E-2	1.14E-1	1.30E-1
41	279.41	2.28E-1	2.66E-1	3.08E-1	3.53E-1	41	169.69	8.33E-2	9.69E-2	1.12E-1	1.27E-1
42	296.21	2.14E-1	2.50E-1	2.90E-1	3.33E-1	42	175.08	8.11E-2	9.45E-2	1.09E-1	1.24E-1
43	314.03	2.02E-1	2.36E-1	2.74E-1	3.15E-1	43	180.52	7.89E-2	9.20E-2	1.06E-1	1.21E-1
44	332.92	1.90E-1	2.23E-1	2.59E-1	2.98E-1	44	186.02	7.66E-2	8.95E-2	1.04E-1	1.19E-1
45	352.94	1.80E-1	2.11E-1	2.45E-1	2.83E-1	45	191.59	7.44E-2	8.70E-2	1.01E-1	1.16E-1
46	374.15	1.70E-1	1.99E-1	2.32E-1	2.68E-1	46	197.21	7.21E-2	8.45E-2	9.80E-2	1.12E-1
47	396.64	1.61E-1	1.89E-1	2.20E-1	2.55E-1	47	202.90	6.99E-2	8.20E-2	9.53E-2	1.10E-1
48	420.44	1.53E-1	1.79E-1	2.09E-1	2.43E-1	48	208.65	6.77E-2	7.96E-2	9.26E-2	1.07E-1
49	445.66	1.45E-1	1.69E-1	1.98E-1	2.31E-1	49	214.48	6.55E-2	7.72E-2	8.99E-2	1.04E-1
50	472.34	1.38E-1	1.61E-1	1.89E-1	2.21E-1	50	220.38	6.38E-2	7.50E-2	8.74E-2	1.01E-1
51	500.58	1.31E-1	1.52E-1	1.79E-1	2.10E-1	51	226.35	6.17E-2	7.27E-2	8.48E-2	9.83E-2
52	530.44	1.25E-1	1.45E-1	1.71E-1	2.01E-1	52	232.39	5.99E-2	7.05E-2	8.24E-2	9.57E-2
53	562.03	1.19E-1	1.39E-1	1.63E-1	1.92E-1	53	238.52	5.76E-2	6.82E-2	7.99E-2	9.31E-2
54	595.41	1.12E-1	1.33E-1	1.56E-1	1.84E-1	54	244.73	5.60E-2	6.62E-2	7.76E-2	9.05E-2
55	630.68	1.06E-1	1.26E-1	1.49E-1	1.77E-1	55	251.02	5.44E-2	6.42E-2	7.54E-2	8.81E-2
56	667.93	1.01E-1	1.21E-1	1.43E-1	1.69E-1	56	257.40	5.27E-2	6.23E-2	7.32E-2	8.57E-2
57	707.26	9.64E-2	1.15E-1	1.37E-1	1.63E-1	57	263.88	5.09E-2	6.03E-2	7.11E-2	8.34E-2
58	748.77	9.21E-2	1.10E-1	1.31E-1	1.56E-1	58	270.44	4.93E-2	5.85E-2	6.90E-2	8.12E-2
59	792.56	8.82E-2	1.05E-1	1.26E-1	1.50E-1	59	277.11	4.78E-2	5.68E-2	6.70E-2	7.91E-2
60	838.73	8.45E-2	1.01E-1	1.20E-1	1.44E-1	60	283.87	4.64E-2	5.51E-2	6.51E-2	7.70E-2
61	887.41	8.10E-2	9.63E-2	1.16E-1	1.39E-1	61	290.74	4.49E-2	5.34E-2	6.32E-2	7.50E-2
62	938.70	7.76E-2	9.23E-2	1.11E-1	1.34E-1	62	297.69	4.35E-2	5.18E-2	6.14E-2	7.30E-2
63	992.74	7.46E-2	8.88E-2	1.06E-1	1.29E-1	63	304.77	4.17E-2	5.02E-2	5.98E-2	7.12E-2
64	1049.62	7.14E-2	8.52E-2	1.02E-1	1.24E-1	64	311.95	4.04E-2	4.87E-2	5.81E-2	6.94E-2
65	1109.52	6.84E-2	8.18E-2	9.83E-2	1.20E-1	65	319.25	3.92E-2	4.73E-2	5.65E-2	6.76E-2
66	1172.55	6.55E-2	7.86E-2	9.46E-2	1.16E-1	66	326.67	3.80E-2	4.59E-2	5.49E-2	6.59E-2
67	1238.85	6.27E-2	7.55E-2	9.12E-2	1.12E-1	67	334.20	3.68E-2	4.45E-2	5.34E-2	6.43E-2
68	1308.57	6.02E-2	7.26E-2	8.78E-2	1.08E-1	68	341.87	3.57E-2	4.32E-2	5.19E-2	6.27E-2
69	1381.88	5.77E-2	6.98E-2	8.47E-2	1.04E-1	69	349.66	3.46E-2	4.20E-2	5.05E-2	6.11E-2
70	1458.91	5.54E-2	6.72E-2	8.16E-2	1.01E-1	70	357.57	3.36E-2	4.07E-2	4.91E-2	5.96E-2
71	1539.85	5.32E-2	6.46E-2	7.88E-2	9.75E-2	71	365.63	3.26E-2	3.95E-2	4.77E-2	5.82E-2
72	1624.86	5.11E-2	6.22E-2	7.60E-2	9.44E-2	72	373.81	3.16E-2	3.84E-2	4.64E-2	5.67E-2
73	1714.14	4.92E-2	5.99E-2	7.34E-2	9.14E-2	73	382.14	3.07E-2	3.73E-2	4.52E-2	5.54E-2
74	1807.85	4.73E-2	5.77E-2	7.09E-2	8.86E-2	74	390.60	2.98E-2	3.62E-2	4.40E-2	5.40E-2
75	1906.22	4.55E-2	5.56E-2	6.85E-2	8.58E-2	75	399.22	2.89E-2	3.52E-2	4.28E-2	5.27E-2
76	2009.42	4.39E-2	5.35E-2	6.62E-2	8.32E-2	76	407.96	2.80E-2	3.42E-2	4.17E-2	5.15E-2
77	2117.70	4.23E-2	5.16E-2	6.40E-2	8.07E-2	77	416.88	2.72E-2	3.32E-2	4.06E-2	5.03E-2
78	2231.26	4.08E-2	4.97E-2	6.19E-2	7.83E-2	78	425.93	2.64E-2	3.22E-2	3.95E-2	4.91E-2
79	2350.36	3.93E-2	4.80E-2	5.98E-2	7.59E-2	79	435.16	2.56E-2	3.13E-2	3.84E-2	4.79E-2
80	2475.19	3.80E-2	4.63E-2	5.79E-2	7.37E-2	80	444.50	2.48E-2	3.04E-2	3.74E-2	4.68E-2
81	2606.04	3.67E-2	4.46E-2	5.60E-2	7.16E-2	81	454.00	2.41E-2	2.96E-2	3.64E-2	4.57E-2
82	2743.19	3.54E-2	4.31E-2	5.42E-2	6.95E-2	82	463.66	2.34E-2	2.88E-2	3.55E-2	4.47E-2
83	2886.93	3.42E-2	4.16E-2	5.24E-2	6.75E-2	83	473.51	2.27E-2	2.79E-2	3.46E-2	4.36E-2
84	3037.59	3.31E-2	4.02E-2	5.08E-2	6.56E-2	84	483.56	2.21E-2	2.72E-2	3.37E-2	4.26E-2
85	3195.40	3.19E-2	3.88E-2	4.92E-2	6.37E-2	85	493.74	2.14E-2	2.64E-2	3.28E-2	4.17E-2
86	3360.31	3.08E-2	3.75E-2	4.76E-2	6.20E-2	86	503.72	2.08E-2	2.57E-2	3.19E-2	4.07E-2
87	3533.40	2.97E-2	3.63E-2	4.61E-2	6.02E-2	87	514.17	2.02E-2	2.49E-2	3.11E-2	3.98E-2
88	3714.60	2.87E-2	3.51E-2	4.47E-2	5.86E-2	88	524.69	1.96E-2	2.42E-2	3.03E-2	3.89E-2
89	3904.42	2.77E-2	3.40E-2	4.33E-2	5.69E-2	89	535.42	1.90E-2	2.36E-2	2.95E-2	3.80E-2
90	4102.98	2.67E-2	3.29E-2	4.20E-2	5.54E-2	90	546.09	1.85E-2	2.29E-2	2.88E-2	3.71E-2
91	4311.19	2.57E-2	3.18E-2	4.07E-2	5.39E-2	91	557.15	1.79E-2	2.23E-2	2.80E-2	3.63E-2
92	4528.69	2.48E-2	3.08E-2	3.94E-2	5.24E-2	92	567.88	1.74E-2	2.16E-2	2.73E-2	3.55E-2

TABLE 2. Collision Strengths as a Function of Scattered Electron Energy E'

See page 14 for Explanation of Tables

$E_1 - A_3$						$E_2 - A_3$					
Z	E_{if}	$E'=0.20$	$E'=0.42$	$E'=0.80$	$E'=1.40$	Z	E_{if}	$E'=0.20$	$E'=0.42$	$E'=0.80$	$E'=1.40$
26	146.70	2.09E-2	2.33E-2	2.62E-2	2.93E-2	26	109.99	7.11E-1	8.36E-1	9.60E-1	1.08E+0
27	154.49	2.47E-2	2.78E-2	3.16E-2	3.55E-2	27	116.17	6.53E-1	7.67E-1	8.81E-1	9.90E-1
28	162.54	2.91E-2	3.31E-2	3.77E-2	4.24E-2	28	122.49	5.99E-1	7.04E-1	8.09E-1	9.10E-1
29	170.88	3.40E-2	3.89E-2	4.45E-2	5.01E-2	29	128.93	5.50E-1	6.46E-1	7.43E-1	8.36E-1
30	179.55	3.93E-2	4.52E-2	5.19E-2	5.86E-2	30	135.49	5.04E-1	5.93E-1	6.82E-1	7.68E-1
31	188.60	4.50E-2	5.20E-2	5.98E-2	6.76E-2	31	142.17	4.63E-1	5.44E-1	6.26E-1	7.05E-1
32	198.08	5.09E-2	5.90E-2	6.79E-2	7.69E-2	32	148.94	4.24E-1	4.99E-1	5.73E-1	6.47E-1
33	208.04	5.69E-2	6.60E-2	7.62E-2	8.64E-2	33	155.79	3.88E-1	4.56E-1	5.25E-1	5.94E-1
34	218.53	6.27E-2	7.30E-2	8.43E-2	9.58E-2	34	162.72	3.54E-1	4.17E-1	4.81E-1	5.44E-1
35	229.62	6.82E-2	7.95E-2	9.20E-2	1.05E-1	35	169.70	3.24E-1	3.81E-1	4.40E-1	4.98E-1
36	241.35	7.36E-2	8.58E-2	9.88E-2	1.13E-1	36	176.74	2.98E-1	3.47E-1	4.00E-1	4.55E-1
37	253.78	7.80E-2	9.11E-2	1.05E-1	1.20E-1	37	183.81	2.72E-1	3.17E-1	3.66E-1	4.16E-1
38	266.97	8.17E-2	9.56E-2	1.10E-1	1.26E-1	38	190.91	2.48E-1	2.89E-1	3.35E-1	3.81E-1
39	280.98	8.47E-2	9.92E-2	1.15E-1	1.31E-1	39	198.04	2.27E-1	2.65E-1	3.06E-1	3.49E-1
40	295.86	8.69E-2	1.02E-1	1.18E-1	1.35E-1	40	205.19	2.08E-1	2.42E-1	2.81E-1	3.21E-1
41	311.66	8.84E-2	1.04E-1	1.20E-1	1.38E-1	41	212.36	1.90E-1	2.22E-1	2.58E-1	2.95E-1
42	328.44	8.92E-2	1.05E-1	1.22E-1	1.40E-1	42	219.55	1.75E-1	2.04E-1	2.37E-1	2.72E-1
43	346.26	8.95E-2	1.05E-1	1.22E-1	1.41E-1	43	226.77	1.61E-1	1.88E-1	2.19E-1	2.51E-1
44	365.18	8.92E-2	1.05E-1	1.22E-1	1.41E-1	44	234.02	1.48E-1	1.74E-1	2.02E-1	2.32E-1
45	385.26	8.85E-2	1.04E-1	1.22E-1	1.41E-1	45	241.29	1.37E-1	1.61E-1	1.87E-1	2.16E-1
46	406.56	8.74E-2	1.03E-1	1.20E-1	1.40E-1	46	248.60	1.27E-1	1.49E-1	1.74E-1	2.01E-1
47	429.14	8.61E-2	1.01E-1	1.19E-1	1.38E-1	47	255.95	1.18E-1	1.39E-1	1.62E-1	1.87E-1
48	453.07	8.47E-2	9.94E-2	1.16E-1	1.36E-1	48	263.34	1.10E-1	1.30E-1	1.51E-1	1.75E-1
49	478.43	8.30E-2	9.73E-2	1.14E-1	1.33E-1	49	270.78	1.03E-1	1.21E-1	1.42E-1	1.64E-1
50	505.28	8.13E-2	9.49E-2	1.12E-1	1.31E-1	50	278.27	9.62E-2	1.13E-1	1.33E-1	1.54E-1
51	533.70	7.90E-2	9.20E-2	1.09E-1	1.28E-1	51	285.81	9.01E-2	1.06E-1	1.25E-1	1.45E-1
52	563.76	7.72E-2	8.98E-2	1.06E-1	1.25E-1	52	293.42	8.49E-2	1.00E-1	1.18E-1	1.37E-1
53	595.56	7.45E-2	8.76E-2	1.03E-1	1.22E-1	53	301.09	7.97E-2	9.45E-2	1.11E-1	1.30E-1
54	629.16	7.17E-2	8.52E-2	1.01E-1	1.19E-1	54	308.83	7.51E-2	8.91E-2	1.05E-1	1.23E-1
55	664.67	6.90E-2	8.25E-2	9.77E-2	1.16E-1	55	316.65	7.12E-2	8.43E-2	9.94E-2	1.17E-1
56	702.18	6.65E-2	7.99E-2	9.49E-2	1.13E-1	56	324.54	6.75E-2	7.99E-2	9.44E-2	1.11E-1
57	741.77	6.43E-2	7.73E-2	9.21E-2	1.10E-1	57	332.52	6.40E-2	7.59E-2	8.97E-2	1.06E-1
58	783.56	6.22E-2	7.47E-2	8.93E-2	1.07E-1	58	340.58	6.07E-2	7.21E-2	8.54E-2	1.01E-1
59	827.64	6.02E-2	7.22E-2	8.65E-2	1.04E-1	59	348.74	5.77E-2	6.86E-2	8.14E-2	9.64E-2
60	874.11	5.83E-2	6.98E-2	8.38E-2	1.01E-1	60	356.99	5.50E-2	6.54E-2	7.77E-2	9.23E-2
61	923.10	5.64E-2	6.74E-2	8.11E-2	9.77E-2	61	365.34	5.24E-2	6.24E-2	7.42E-2	8.84E-2
62	974.71	5.45E-2	6.51E-2	7.85E-2	9.49E-2	62	373.78	5.00E-2	5.96E-2	7.10E-2	8.48E-2
63	1029.08	5.27E-2	6.32E-2	7.59E-2	9.20E-2	63	382.34	4.70E-2	5.68E-2	6.80E-2	8.15E-2
64	1086.31	5.08E-2	6.11E-2	7.35E-2	8.93E-2	64	390.99	4.50E-2	5.44E-2	6.52E-2	7.83E-2
65	1146.55	4.90E-2	5.91E-2	7.11E-2	8.67E-2	65	399.77	4.30E-2	5.21E-2	6.26E-2	7.53E-2
66	1209.94	4.72E-2	5.71E-2	6.89E-2	8.42E-2	66	408.66	4.12E-2	5.00E-2	6.01E-2	7.26E-2
67	1276.61	4.55E-2	5.51E-2	6.67E-2	8.18E-2	67	417.68	3.95E-2	4.80E-2	5.78E-2	6.99E-2
68	1346.71	4.38E-2	5.33E-2	6.46E-2	7.94E-2	68	426.83	3.80E-2	4.61E-2	5.56E-2	6.75E-2
69	1420.41	4.22E-2	5.15E-2	6.26E-2	7.72E-2	69	436.11	3.64E-2	4.43E-2	5.36E-2	6.51E-2
70	1497.84	4.07E-2	4.97E-2	6.06E-2	7.50E-2	70	445.50	3.50E-2	4.26E-2	5.16E-2	6.29E-2
71	1579.20	3.92E-2	4.81E-2	5.87E-2	7.28E-2	71	455.05	3.37E-2	4.10E-2	4.98E-2	6.08E-2
72	1664.63	3.78E-2	4.64E-2	5.69E-2	7.08E-2	72	464.72	3.24E-2	3.95E-2	4.80E-2	5.89E-2
73	1754.34	3.65E-2	4.48E-2	5.51E-2	6.88E-2	73	474.54	3.12E-2	3.80E-2	4.63E-2	5.70E-2
74	1848.50	3.52E-2	4.33E-2	5.34E-2	6.68E-2	74	484.51	3.00E-2	3.67E-2	4.47E-2	5.52E-2
75	1947.33	3.40E-2	4.19E-2	5.18E-2	6.50E-2	75	494.63	2.89E-2	3.53E-2	4.32E-2	5.35E-2
76	2051.00	3.29E-2	4.04E-2	5.02E-2	6.32E-2	76	504.89	2.79E-2	3.41E-2	4.18E-2	5.19E-2
77	2159.77	3.18E-2	3.91E-2	4.86E-2	6.14E-2	77	515.32	2.69E-2	3.29E-2	4.04E-2	5.03E-2
78	2273.83	3.07E-2	3.77E-2	4.71E-2	5.97E-2	78	525.90	2.59E-2	3.18E-2	3.91E-2	4.88E-2
79	2393.45	2.97E-2	3.65E-2	4.57E-2	5.81E-2	79	536.65	2.50E-2	3.07E-2	3.79E-2	4.74E-2
80	2518.81	2.87E-2	3.53E-2	4.43E-2	5.65E-2	80	547.53	2.42E-2	2.97E-2	3.67E-2	4.60E-2
81	2650.21	2.78E-2	3.41E-2	4.29E-2	5.50E-2	81	558.57	2.33E-2	2.87E-2	3.55E-2	4.47E-2
82	2787.93	2.69E-2	3.30E-2	4.16E-2	5.35E-2	82	569.78	2.25E-2	2.78E-2	3.44E-2	4.35E-2
83	2932.26	2.60E-2	3.19E-2	4.04E-2	5.21E-2	83	581.18	2.18E-2	2.68E-2	3.34E-2	4.23E-2
84	3083.53	2.52E-2	3.09E-2	3.91E-2	5.07E-2	84	592.79	2.11E-2	2.60E-2	3.23E-2	4.11E-2
85	3241.98	2.44E-2	2.99E-2	3.80E-2	4.93E-2	85	604.54	2.03E-2	2.51E-2	3.14E-2	4.00E-2
86	3407.54	2.35E-2	2.89E-2	3.68E-2	4.80E-2	86	616.10	1.97E-2	2.43E-2	3.04E-2	3.89E-2
87	3581.33	2.27E-2	2.80E-2	3.57E-2	4.67E-2	87	628.14	1.90E-2	2.36E-2	2.95E-2	3.79E-2
88	3763.23	2.20E-2	2.71E-2	3.47E-2	4.55E-2	88	640.26	1.84E-2	2.28E-2	2.87E-2	3.69E-2
89	3953.80	2.12E-2	2.63E-2	3.36E-2	4.43E-2	89	652.59	1.78E-2	2.21E-2	2.78E-2	3.59E-2
90	4153.13	2.05E-2	2.54E-2	3.26E-2	4.31E-2	90	664.87	1.72E-2	2.14E-2	2.70E-2	3.50E-2
91	4362.15	1.98E-2	2.47E-2	3.17E-2	4.20E-2	91	677.54	1.67E-2	2.07E-2	2.62E-2	3.41E-2
92	4580.50	1.91E-2	2.39E-2	3.07E-2	4.09E-2	92	689.90	1.61E-2	2.01E-2	2.55E-2	3.32E-2