**RELATIVISTIC DISTORTED-WAVE COLLISION STRENGTHS
FOR $\Delta n = 0$ TRANSITIONS
IN THE 67 LI-LIKE, F-LIKE AND NA-LIKE IONS WITH $26 \leq Z \leq 92$**

CHRISTOPHER J. FONTES AND HONG LIN ZHANG

Computational Physics Division

Los Alamos National Laboratory, Los Alamos, NM 87545

Relativistic distorted-wave collision strengths have been calculated for all possible $\Delta n = 0$ transitions, where n denotes the valence shell of the ground level, in the 67 Li-like, F-like and Na-like ions with Z in the range $26 \leq Z \leq 92$. This choice produces 3 transitions with $n = 2$ in the Li-like and F-like ions, and 10 transitions with $n = 3$ in the Na-like ions. For the Li-like and F-like ions, the calculations were made for the six final, or scattered, electron energies $E' = 0.008, 0.04, 0.10, 0.21, 0.41$, and 0.75 , where E' is in units of Z_{eff}^2 Ry with $Z_{\text{eff}} = Z - 1.66$ for Li-like ions and $Z_{\text{eff}} = Z - 6.667$ for F-like ions. For the Na-like ions, the calculations were made for the six final electron energies $E' = 0.0025, 0.015, 0.04, 0.10, 0.21$, and 0.40 , with $Z_{\text{eff}} = Z - 8.34$. 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 works by Zhang, Sampson and Fontes [H.L. Zhang, D.H. Sampson and C.J. Fontes, *At. Data and Nucl. Data Tables* 44 (1990) 31; H.L. Zhang, D.H. Sampson and C.J. Fontes, *At. Data and Nucl. Data Tables* 48 (1991) 25; D.H. Sampson, H.L. Zhang, and C.J. Fontes, *At. Data and Nucl. Data Tables* 44 (1990) 209]. In those previous works, collision strengths

were also provided for Li-, F- and Na-like ions, but for a more comprehensive set of transitions. The collision strengths covered in the present work should be more accurate than the corresponding data given in those previous works and are presented here to replace those earlier results.

CONTENTS

INTRODUCTION	3
EXPLANATION OF TABLES	13
TABLES	
I. Transition Energies E_{if} (eV) for Li-like Ions	15
II. Transition Energies E_{if} (eV) for F-like Ions	16
III. Transition Energies E_{if} (eV) for Na-like Ions	17
IV. Electric Dipole Oscillator Strengths for Li-like Ions	18
V. Electric Dipole Oscillator Strengths for F-like Ions	19
VI. Electric Dipole Oscillator Strengths for Na-like Ions	20
VII. Collision Strengths as a Function of Scattered Electron Energy E' for Li-like ions	15
VIII. Collision Strengths as a Function of Scattered Electron Energy E' for F-like ions	16
IX. Collision Strengths as a Function of Scattered Electron Energy E' for Na-like ions	17

INTRODUCTION

This paper is the sixth and final in a series aimed at providing improved electron-impact excitation collision strengths for an isoelectronic sequence. The present work deals with Li-like, F-like and Na-like ions in a manner similar to that described in recently completed works on Be-like [4], B-like [5], C-like [6], N-like [7] and O-like [8] ions. These three isoelectronic sequences have been combined in the present work because their ground configurations are all described by a single electron outside of a closed shell and so the relevant physics and computational issues are similar.¹ Of course, in the case of F-like ions, the ground configuration is actually described by a single hole in the $n = 2$ shell, rather than a single electron, but the angular momentum coupling of the relevant levels is formally identical to the case of Li-like ions.

Li-like, F-like and Na-like ions are of considerable interest for the study and modeling of high-temperature astrophysical and laboratory plasmas, e.g. [10–14]. 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 the 3 possible $\Delta n = 0$ transitions among the 3 levels arising from the $1s^2 2s$ and $1s^2 2p$ configurations of all Li-like ions with Z in the range

$$8 \leq Z \leq 92. \quad (1)$$

Similarly, in Refs. [2, 3], collision strengths were provided for the 3 possible $\Delta n = 0$ transitions among the 3 levels arising from the $1s^2 2s^2 2p^5$ and $1s^2 2s^2 2p^6$ configurations of all F-like ions, and for the 10 possible $\Delta n = 0$ transitions among the 3 levels arising from the $1s^2 2s^2 2p^6 3s$, $1s^2 2s^2 2p^6 3p$ and $1s^2 2s^2 2p^6 3d$ configurations of all Na-like ions, respectively, with Z in the range

$$22 \leq Z \leq 92. \quad (2)$$

¹For completeness, we mention that we also have similar, previously published results for Cu-like ions [9], which possess a ground configuration with an $n = 4$ electron outside of a closed $n = 3$ shell. However, the improved top-up treatment considered here did not produce a significant improvement in any of the collision strengths in that earlier work and so they are excluded from the present study. No improvement was observed in this case because the valence shell is $n = 4$ for these ions and the relevant free-electron energies under consideration were sufficiently low that a relativistic top-up treatment was not warranted.

(For completeness, we mention that Refs. [1–3] also contain results for $\Delta n = 1$ transitions.) These previous results were calculated with an improved version [15] of the rapid relativistic distorted-wave (RDW) code of Ref. [16]. For additional details of our RDW codes, a comprehensive review is available in Ref. [17]. These previous $\Delta n = 0$ calculations were made for Li-like and F-like ions for the six scattered, or final, electron energies

$$E' = 0.008, 0.04, 0.10, 0.21, 0.41 \text{ and } 0.75, \quad (3)$$

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

$$Z_{\text{eff}} = Z - 1.66 \quad (4)$$

for Li-like ions and

$$Z_{\text{eff}} = Z - 6.667 \quad (5)$$

for F-like ions. Similarly, the previous Na-like calculations were made for the six scattered energies given by

$$E' = 0.0025, 0.015, 0.04, 0.10, 0.21 \text{ and } 0.40, \quad (6)$$

with

$$Z_{\text{eff}} = Z - 8.34. \quad (7)$$

The electric dipole oscillator strengths were also provided in Refs. [1–3].

We note that the precise choice for Z_{eff} is not very crucial. Equations (4), (5) and (7) correspond 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 $N = 3, 9$ and 11 , respectively.

The range of energies covered by Eqs. (3) and (6) 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 [18], as described by Eqs. (18)–(20) in Ref. [19], was used with the fully relativistic electric-dipole line strength S calculated with the multi-configuration Dirac-Fock (MCDF) structure code of Grant and coworkers [20, 21] (or by our Dirac-Fock-Slater (DFS) structure code [22] 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 Li-like ions, by

$$f_{if} = \frac{E_{if}}{3g_i} S_{if}, \quad (8)$$

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 Refs. [1–3], the collision strengths obtained with this procedure may not be very accurate for high- Z ions and for high incident-electron energies.

In a recent publication, we derived an expression for the complete electron-impact excitation collision strength in the relativistic plane-wave Born (RPWB) approximation [23]. (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 [24] (see Eq. (4.75) of Ref. [17] and the surrounding discussion for more details). Using this top-up procedure, the complete RDW collision strength can be written in the form

$$\Omega^{\text{RDW}} \approx \sum_{l=0}^{l_0} \Omega_l^{\text{RDW}} + (\Omega^{\text{RPWB}} - \sum_{l=0}^{l_0} \Omega_l^{\text{RPWB}}), \quad (9)$$

where the l index denotes a partial wave of the incident-electron wave function. 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

$$\kappa = l, \quad j = l - \frac{1}{2}; \quad \kappa = -(l + 1), \quad j = l + \frac{1}{2}. \quad (10)$$

For additional details concerning this RPWB top-up procedure, the reader is directed to Refs. [4, 17].

In view of this new, more accurate top-up capability, we investigated its effect on our previously published $\Delta n = 0$ collision strengths for Li-, F- and Na-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 strengths for the 3 $\Delta n = 0$ transitions with $n = 2$ in Li-like and F-like ions, for the six energies listed in Eq. (3). These new calculations were done for Z in the range

$$26 \leq Z \leq 92. \quad (11)$$

Similarly, we repeated the calculations of the collision strengths for the 10 $\Delta n = 0$ transitions with $n = 3$ in Na-like ions, for the six energies listed in Eq. (6), and for Z also in the range given by Eq. (11).

The decision to also include calculations of collision strengths for the forbidden transitions in the present work, even though they were not significantly impacted by the more accurate top-up treatment, was based on the fact that the current calculations employ the MCDF structure approach. The latter treatment should result in more accurate results compared to those obtained with the DFS structure approach used in our earlier work. In addition, F-like collision strengths were only presented for every fourth Z value in Ref. [2], while every Z value within the range of Eq. (11) is considered here. So a significant amount of the F-like data are being published for the first time. We also decided to include the corresponding transition energies, as well as oscillator strengths for the optically allowed transitions, in this work. While those data are not expected to be significantly improved with the present MCDF approach, it is desirable to provide a complete and consistent set of atomic data, generated from a single set of codes. As described in our earlier work [1–3], those previous transition energies and oscillator strengths were obtained using somewhat disparate methods.

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 [31], as well as those used for Be-like [4, 25], B-like [5, 26, 27], C-like [6, 28, 29], N-like [7, 30] and O-like [8, 31] ions. That is, relativistic atomic structure data obtained with the “average level” option of

the MCDF code of Grant and coworkers [20,21] 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 [32,33]. We evaluate this potential using a mean configuration, which in the present calculations for Li-like ions was chosen to be the same as that appearing in Eq. (7) of Ref. [1]. That is,

$$1s_{1/2}^2 \ 2s_{1/2}^{0.33} \ 2p_{1/2}^{0.33} \ 2p_{3/2}^{0.34} \quad (12)$$

was used to obtain wave functions for both the impact and scattered electrons. Similarly, the mean configuration used for F-like ions was the same as that appearing in Eq. (8) of Ref. [2], i.e.

$$1s_{1/2}^2 \ 2s_{1/2}^{1.9} \ 2p_{1/2}^{1.9} \ 2p_{3/2}^{3.2}, \quad (13)$$

and the mean configuration used for Na-like ions was the same as that appearing in Eq. (7) of Ref. [3], i.e.

$$1s_{1/2}^2 \ 2s_{1/2}^2 \ 2p_{1/2}^2 \ 2p_{3/2}^4 \ 3s_{1/2}^{0.2} \ 3p_{1/2}^{0.2} \ 3p_{3/2}^{0.2} \ 3d_{3/2}^{0.2} \ 3d_{5/2}^{0.2}. \quad (14)$$

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

$$Q(i-f) = \frac{\pi a_0^2}{k_i^2 g_i} \Omega(i-f), \quad (15)$$

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

$$k_i^2 = \epsilon_i(\text{Ry}) \left[1 + \frac{\alpha^2}{4} \epsilon_i(\text{Ry}) \right], \quad (16)$$

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

$$\epsilon_i(\text{Ry}) = E_{if}(\text{Ry}) + Z_{\text{eff}}^2 E', \quad (17)$$

in which E_{if} is the transition energy and Z_{eff} is given by Eq. (4), (5) or (7), for Li-, F- or Na-like ions, respectively. In the present application, as mentioned above, the final electron energy E' takes on the values given by Eq. (3) for Li- and F-like ions or by Eq. (6) for Na-like ions.

In our most recent and earlier works concerning collision strengths for complex ions [4–8, 25–31], we used the factorization formulation of Bar-Shalom *et al.* [34] to

express the collision strengths in the form

$$\Omega = 8 \sum_{\substack{j_a, j'_a \\ j_{a1}, j'_{a1}}} \sum_{\lambda} B^{\lambda}(j_a j'_a, j_{a1} j'_{a1}) Q^{\lambda}(j_a j'_a, j_{a1} j'_{a1}), \quad (18)$$

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 wave function, while j'_a and j'_{a1} represent orbitals in the final target-ion wave function. A convenient feature of Eq. (18) 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. [34].)

However, in the present case of single-electron type ions, no mixing, or configuration interaction, was considered when determining the energy levels and the factorization formula can be written in the simpler form

$$\Omega(n_a l_a j_a - n'_a l'_a j'_a) = 8 \sum_{\lambda} Q^{\lambda}(j_a j'_a, j_{a1} j'_{a1}) \quad (19)$$

where $n_a l_a j_a - n'_a l'_a j'_a$ denotes both an orbital-orbital transition and its corresponding level-level transition. Thus, the present collision strength calculations can be performed in a manner similar to that used for hydrogenic ions. The main difference is that the necessary bound and free orbitals are calculated from non-hydrogenic potentials, as described above. Of course in the present calculations we used the Kummer transformation, Eq. (9), 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 (34, 34, 38, 51, 58 and 61 for Li-like ions, 34, 34, 38, 51, 58 and 61 for F-like ions, and 34, 34, 34, 38, 51 and 58 for Na-like ions) were used for the six scattered energies given in Eqs. (3) and (6) 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 significantly larger than those used in our previous calculations described in Refs. [1–3].

In labeling the levels and transitions described in the tables below, the following abbreviations are used: For Li-like ions, the three $n = 2$ levels are denoted by

$$2s \equiv (1s^2 2s)_{J=1/2}, \quad 2p^* \equiv (1s^2 2p_{1/2})_{J=1/2}, \quad 2p \equiv (1s^2 2p_{3/2})_{J=3/2}, \quad (20)$$

where J represents the total angular momentum quantum number of a given level. For F-like ions, the three $n = 2$ levels are denoted by

$$2s \equiv (1s^2 2s)_{J=1/2}, \quad 2p^* \equiv (1s^2 2p_{1/2})_{J=1/2}, \quad 2p \equiv (1s^2 2p_{3/2})_{J=3/2}, \quad (21)$$

where the level label in this case indicates a hole, rather than an electron, in the $n = 2$ shell. For Na-like ions, the five $n = 3$ levels are denoted by

$$\begin{aligned} 3s &\equiv (1s^2 2s^2 2p_{1/2}^2 2p_{3/2}^4 3s)_{J=1/2}, & 3p^* &\equiv (1s^2 2s^2 2p_{1/2}^2 2p_{3/2}^4 3p_{1/2})_{J=1/2}, \\ 3p &\equiv (1s^2 2s^2 2p_{1/2}^2 2p_{3/2}^4 3p_{3/2})_{J=3/2}, & 3d^* &\equiv (1s^2 2s^2 2p_{1/2}^2 2p_{3/2}^4 3d_{3/2})_{J=3/2}, \\ 3d &\equiv (1s^2 2s^2 2p_{1/2}^2 2p_{3/2}^4 3d_{5/2})_{J=5/2}. \end{aligned} \quad (22)$$

A list of transition energies in eV is provided in Tables I–III for Li-, F- and Na-like ions, respectively. As mentioned above, these energies were obtained with the MCDF code of Grant and coworkers [20, 21]. Because $\Delta n = 0$ transition energies can be somewhat sensitive to higher-order effects, particularly for large Z values (see, for example, Ref. [1]), these transition energies were calculated with the Breit interaction and QED corrections (vacuum polarization and self-energy) included. These higher-order effects were also included in our previous work [1–3], but, as described in those references, these effects were evaluated with somewhat different codes and methods. A comparison of the present transition energies with those earlier results shows very good agreement for most transitions, typically within 1% and often with 0.1%. While such accuracy may not be of spectroscopic quality for line identification purposes, it is adequate for the calculation of the oscillator strengths and collision strengths presented here. A notable exception to the above level of accuracy is observed for the small $3s - 3p^*$ transition energy for high Z values in the Na-like ions. In that case, the discrepancy with our previous results [3] reaches a maximum of 5.3% at $Z = 92$. As in the present work, those earlier results were also computed with the MCDF code of Grant and coworkers, and so the two sets of results were expected to agree quite well. However, the QED corrections in those earlier calculations appear to have contained an error and the present transition energies for all of the $n = 3-3$ transitions, not just the $3s - 3p^*$ transition, are expected to be more accurate.

The oscillator strengths for all possible electric dipole radiative $\Delta n = 0$ transitions among the levels discussed above are provided in Tables IV–VI. Table IV contains results for the 2 transitions among the $n = 2$ levels of Li-like ions, Table V contains results for the 2 transitions among the $n = 2$ levels of F-like ions, and Table VI contains results for the 5 transitions among the $n = 3$ levels of Na-like ions. The present calculations

include the effect of retardation, which was also included in our earlier work on F-like ions [2], but omitted from our previous calculations of Li- and Na-like ions [1, 3]. As mentioned in those earlier works, the effect of retardation is expected to be small when the active electron is from a shell described by $n > 1$, which includes all of the transitions currently under consideration. In fact, similar to the transition energies described above, the present oscillator strengths typically agree with those earlier results to within 1% or less. As in the analysis of the transition energies, a notable exception in this level of accuracy is observed for the weak $3s - 3p^*$ transition in Na-like ions, for which the agreement in the oscillator strength worsens with increasing Z values, with the maximum discrepancy reaching 5.9% at $Z = 92$. Since the oscillator strength is proportional to the transition energy, and the energy for this particular transition was found to differ from the previously published result by 5.3%, a similar discrepancy in the oscillator strength is not surprising.

The collision strengths for all possible $\Delta n = 0$ transitions among the $n = 2$ levels in Li-like ions, among the $n = 2$ levels in F-like ions, and among the $n = 3$ levels in Na-like ions are presented in Tables VII–IX, respectively. These data are presented for Z values in the range specified by Eq. (11) and for the six scattered energies presented in the appropriately chosen Eq. (3) or (6). In our most recent and earlier works concerning collision strengths for complex ions [4–8, 25–31], the values of Q^λ appearing in Eq. (18) were calculated at several transition energies that span the range of physical, level-level transition energies for each of the six scattered electron energies appearing in Eq. (3) or (6), for a given Z value. Then these results were used to obtain Q^λ values at the exact energy of each transition via Lagrange interpolation. As mentioned above, in the present case of single-electron type ions, no mixing was considered and the collision strengths can be evaluated in a similar manner to that used for hydrogenic ions, via the simpler expression that appears in Eq. (19). Hence, each Q^λ value associated with a pair of bound nlj orbitals must be evaluated only one time, at the precise transition associated with that pair’s corresponding level-level transition energy. Furthermore, in our earlier works concerning these single-electron ions [1–3], detailed calculations of Q^λ were made for a small, representative set of Z values, and then a polynomial fit formula, expressed as a function of Z , was used to calculate collision strengths for all Z values in the desired range. In the present work, no such fitting was employed. The collision strengths presented here were explicitly evaluated at each Z value and represent the most accurate possible data that we can provide for Li-, F- and Na-like ions.

Before considering the collision strength data in Tables VII–IX, 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. [35] and [36] (see also Section 4.14 of Ref. [17]), this relation is given by

$$\begin{aligned} C_{if} &= \alpha \pi a_0^2 \sqrt{\frac{2kT}{m}} \sqrt{\frac{I_H}{kT}} \frac{\Upsilon_{if}}{g_i \exp(mc^2/kT) K_2(mc^2/kT)} \exp(-E_{if}/kT) \\ &= 2\pi^{1/2} \alpha c a_0^2 \sqrt{\frac{I_H}{kT}} \frac{\Upsilon_{if}}{g_i G(kT/mc^2)} \exp(-E_{if}/kT), \end{aligned} \quad (23)$$

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

$$\Upsilon_{if} \equiv \int_0^\infty \Omega(i - f) \exp(-\epsilon_f/kT) d(\epsilon_f/kT), \quad (24)$$

in which $\epsilon_f = Z_{\text{eff}}^2 E'$ is the scattered, or final, electron energy in Rydbergs. In the second line of Eq. (23), 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. [37], except for the presence of the function $G(kT/mc^2)$, which is defined by

$$G(kT/mc^2) \equiv \sqrt{\frac{2}{\pi} \left(\frac{mc^2}{kT} \right)} \exp(mc^2/kT) K_2(mc^2/kT). \quad (25)$$

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. [24] to obtain

$$G(kT/mc^2) = 1 + \frac{15}{8} \frac{kT}{mc^2} + \frac{105}{128} \left(\frac{kT}{mc^2} \right)^2 - \frac{315}{1024} \left(\frac{kT}{mc^2} \right)^3 + \frac{10395}{32768} \left(\frac{kT}{mc^2} \right)^4 + \dots \quad (26)$$

Finally, we note that in writing Eq. (23), it was assumed that i is the lower level. If this is not the case, then the exponential factor should be omitted.

Comparing the Li-like collision strength data in Table VII of the present work with those in Table III of Ref. [1], one sees that for lower Z values, the agreement is quite good. Also, for the lower scattered energies in Table II, the agreement is also very good over the entire range of Z values. A notable exception occurs at the lowest two scattered energies for the $2s - 2p^*$ transition in the vicinity of $Z = 50$ and 80 , where the discrepancies are as high as 4.7% and 6.9%, respectively. The reason for this discrepancy is predominantly due to the use of the Coulomb-Bethe versus RPWB top-up procedures

Figure 1: A plot of collision strengths for the $2s - 2p^*$ transition in Li-like xenon ($Z = 54$) and uranium ($Z = 92$). The solid lines represent collision strengths calculated with the RPWB top-up method presented in Eq. (9), while the dashed lines represent collision strengths calculated with the partial-relativistic Coulomb-Bethe (PRCBe) method.

in these two works, along with the chosen values of l_0 . However, for higher energies, especially for the largest value of $E' = 0.75 Z_{\text{eff}}^2$ Ry, the new results become progressively larger with increasing Z value, up to a 21% increase for the $2s - 2p^*$ transition. On the other hand, the dipole forbidden $2p^* - 2p$ transition displays very little sensitivity to the top-up contribution for all Z , in agreement with the previous discussion. As an illustration of the strong top-up behavior, we present collision strengths for the $2s - 2p^*$ transition in Li-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 21% observed at the highest impact energy.

Comparisons of the present F-like and Na-like collision strength data in the present work with the our corresponding earlier works yield trends similar to those described above for Li-like ions at high incident energies. The F-like data in Table VIII can be compared directly with those in Table IV of Ref. [2], while the Na-like data in Table IX should be compared with those in Table III of Ref. [3]. As expected, the new RPWB

top-up procedure yields larger values with increasing Z and impact energy. A maximum increase of 16% is obtained for the dipole allowed $2p^* - 2s^*$ transition in F-like uranium, while a maximum increase of 8.7% is obtained for the dipole allowed $3p - 3d^*$ transition in Na-like uranium. These percentages are somewhat lower than those encountered for Li-like ions due to the lower (less relativistic) energies associated with the bound and continuum electrons of these more complicated F- and Na-like ions.

At lower energies, the agreement between the present and earlier collision strengths is generally quite good for these two ion stages. A notable exception occurs for the $2p^* - 2s$ transition and, to a lesser extent, for the $2p - 2s$ transition, in F-like ions. Unexpectedly large (~ 10 – 20%) differences are observed for the former transition over a significant portion of the Z -value range, while differences of ~ 5 – 10% occur for the latter transition. Unlike the case of Li-like ions, these large discrepancies can not be attributed to a difference in top-up methods. After a detailed investigation, we have determined that the previous F-like results are inaccurate for those two transitions. This inaccuracy appears to be caused by the combination of interpolation and fitting procedures described above and in Ref. [2]. No such approximations were employed in the present work and therefore the current F-like collision strengths are recommended for future use. The largest discrepancies between the two Na-like data sets are confined to the low end of the Z -value range and can be attributed to a difference in top-up methods, and particularly the selected values of l_0 . The maximum difference is 5.3%, which occurs at the lowest energy for the $3d^* - 3d$ transition with $Z = 26$.

While the Li-, F- and Na-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. [38] 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 expected to become progressively less important as Z increases through the range of values listed in Eq. (11). The resonance contributions are not expected to be very important for any of the strong optically allowed transitions in this range, and should become less significant for the weaker transitions with increasing Z . (See additional discussion of resonances below.) In conclusion, we expect that the present results for the $\Delta n = 0$ transitions currently under consideration should be quite accurate for the range of ions and energies given in Eqs. (11) and (6). We note that, as mentioned in other work (see, for example, Ref. [28]), our collision

strengths for the low- Z end of the range of ions considered in the earlier Refs. [1–3] could be inaccurate by about 20% due to the omission of mixing with configurations containing electrons in n shells beyond the valence shell of the ground configuration. 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 Refs. [1–3], 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 the close-coupling R-matrix method, have been published that contain results for Li-, F- and Na-like ions that overlap with those considered in this work, e.g. [39–41]. As expected, these works illustrate 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 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 diminishes as the ion charge increases (due to radiation damping [42, 43]) 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 (IPIR) method [17, 43–46].

The complete set of Li-, F- and Na-like results (including transitions energies, oscillator strengths and collision strengths), with the collision strengths evaluated for all 6 energies specified in Eq. (3) or (6), 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. For Li-like ions, the complete set includes all 85 Z values within the range specified in Eq. (1), i.e. $9 \leq Z \leq 92$, with the data presented in Tables I, IV and VII replacing the corresponding data in Ref. [1] for $Z \geq 26$. For F- and Na-like ions, the complete set

includes all 71 Z values within the range specified in Eq. (2), i.e. $22 \leq Z \leq 92$. The data presented in Tables II, V and VIII replace the corresponding F-like data in Ref. [2], and the data presented in Tables III, VI and IX replace the corresponding Na-like data in Ref. [3], for $Z \geq 26$.

Acknowledgments

This work was performed under the auspices of the U.S. Department of Energy by Los Alamos National Laboratory under Contract No. DE-AC52-06NA25396.

References

- [1] H.L. Zhang, D.H. Sampson and C.J. Fontes, At. Data and Nucl. Data Tables 44 (1990) 31.
- [2] H.L. Zhang, D.H. Sampson and C.J. Fontes, At. Data and Nucl. Data Tables 48 (1991) 25.
- [3] D.H. Sampson, H.L. Zhang, and C.J. Fontes, At. Data and Nucl. Data Tables 44 (1990) 209.
- [4] H.L. Zhang and C.J. Fontes, At. Data and Nucl. Data Tables 99 (2013) 416.
- [5] C.J. Fontes and H.L. Zhang, At. Data and Nucl. Data Tables 100 (2014) 802.
- [6] H.L. Zhang and C.J. Fontes, At. Data and Nucl. Data Tables 101 (2015) 41.
- [7] C.J. Fontes and H.L. Zhang, At. Data and Nucl. Data Tables 100 (2014) 1292.
- [8] C.J. Fontes and H.L. Zhang, At. Data and Nucl. Data Tables 101 (2015) 143.
- [9] H.L. Zhang, D.H. Sampson and C.J. Fontes, At. Data and Nucl. Data Tables 44 (1990) 273.
- [10] M.F. Gu, Astrophys. J. 582 (2003) 1241.
- [11] P. Desai et al, Astrophys. J. 625 (2005) L59.
- [12] H. Chen et al, Astrophys. J. 646 (2006) 653.

- [13] M.F. Gu, R. Gupta, J.R. Peterson, M. Sako and S.M. Kahn, *Astrophys. J.* 649 (2006) 979.
- [14] F.P. Keenan, J.J. Drake and K.M. Aggarwal, *Mon. Not. R. Astron. Soc.* 381 (2007) 1727.
- [15] H.L. Zhang and D.H. Sampson, *Phys. Rev. A* 47 (1993) 208.
- [16] H.L. Zhang, D.H. Sampson and A.K. Mohanty, *Phys. Rev. A* 40 (1989) 616.
- [17] D.H. Sampson, H.L. Zhang and C.J. Fontes, *Physics Reports* 477 (2009) 111.
- [18] A. Burgess and V.B. Sheorey, *J. Phys. B* 7 (1974) 2403.
- [19] H.L. Zhang and D.H. Sampson, *Phys. Rev. A* 52 (1995) 3827.
- [20] I.P. Grant, B.J. McKenzie, P.H. Norrington, D.F. Mayers and N.C. Pyper, *Comput. Phys. Commun.* 21 (1980) 207.
- [21] B.J. McKenzie, I.P. Grant and P.H. Norrington, *Comput. Phys. Commun.* 21 (1980) 233.
- [22] D.H. Sampson, H.L. Zhang, A.K. Mohanty and R.E.H Clark, *Phys. Rev. A* 40 (1989) 604.
- [23] C.J. Fontes and H.L. Zhang, *Phys. Rev. A* 76 (2007) 040703(R).
- [24] M. Abramowitz and I.A. Stegun, *Handbook of Mathematical Functions*, (Dover, New York, 1972).
- [25] H.L. Zhang and D.H. Sampson, *At. Data and Nucl. Data Tables* 52 (1992) 143.
- [26] H.L. Zhang and D.H. Sampson, *At. Data and Nucl. Data Tables* 56 (1994) 41.
- [27] H.L. Zhang and D.H. Sampson, *At. Data and Nucl. Data Tables* 58 (1994) 255.
- [28] H.L. Zhang and D.H. Sampson, *At. Data and Nucl. Data Tables* 63 (1996) 275.
- [29] H.L. Zhang and D.H. Sampson, *At. Data and Nucl. Data Tables* 65 (1997) 183.
- [30] H.L. Zhang and D.H. Sampson, *At. Data and Nucl. Data Tables* 72 (1999) 153.
- [31] H.L. Zhang and D.H. Sampson, *At. Data and Nucl. Data Tables* 82 (2002) 357.

- [32] J.B. Mann, *At. Data and Nucl. Data Tables* 29 (1983) 407.
- [33] J.B. Mann, Results for fine-structure transitions in iron ions, 1982 (unpublished).
See Ref. [10] of Ref. [28].
- [34] A. Bar-Shalom, M. Klapisch and J. Oreg, *Phys. Rev. A* 38 (1988) 1773.
- [35] C.J. Fontes, D.H. Sampson and H.L. Zhang, *At. Data and Nucl. Data Tables* 72 (1999) 217.
- [36] D.H. Sampson and H.L. Zhang, *J. Quant. Spectrosc. Radiat. Transfer* 54 (1995) 345.
- [37] J. Lang, *At. Data and Nucl. Data Tables* 57 (1994) 1.
- [38] C.J. Fontes, D.H. Sampson and H.L. Zhang, *Phys. Rev. A* 47 (1993) 1009.
- [39] M.C. Witthoeft, A.D. Whiteford and N.R. Badnell, *J. Phys. B: At. Mol. Opt. Phys.* 40 (2007) 2969.
- [40] G.Y. Liang, A.D. Whiteford and N.R. Badnell, *Astron. Astrophys.* 500 (2009) 1263.
- [41] G.Y. Liang and N.R. Badnell, *Astron. Astrophys.* 528 (2011) A69.
- [42] H.L. Zhang and A.K. Pradhan, *Astron. & Astrophys. Suppl. Ser.* 123 (1997) 575.
- [43] M.F. Gu, *Phys. Rev. A* 70 (2004) 062704.
- [44] R.D. Cowan, *The Theory of Atomic Structure and Spectra*, (University of California Press, Berkeley, 1981).
- [45] J. Oelgoetz, C.J. Fontes, H.L. Zhang, S.N. Nahar and A.K. Pradhan, *Mon. Not. R. Astron. Soc.* 394 (2009) 742.
- [46] C.J. Fontes and H.L. Zhang, (in preparation).

EXPLANATION OF TABLES

- TABLE I. Transition Energies E_{if} (eV) for Li-like Ions**
 This table gives the transition energies (in eV) for transitions $i - f$ for Li-like ions.
- TABLE II. Transition Energies E_{if} (eV) for F-like Ions**
 This table gives the transition energies (in eV) for transitions $i - f$ for F-like ions.
- TABLE III. Transition Energies E_{if} (eV) for Na-like Ions**
 This table gives the transition energies (in eV) for transitions $i - f$ for Na-like ions.
- TABLE IV. Electric Dipole Oscillator Strengths for Li-like Ions**
 This table gives the (dimensionless) electric dipole oscillator strength for the allowed transitions in Li-like ions.
- TABLE V. Electric Dipole Oscillator Strengths for F-like Ions**
 This table gives the (dimensionless) electric dipole oscillator strength for the allowed transitions in F-like ions.
- TABLE VI. Electric Dipole Oscillator Strengths for Na-like Ions**
 This table gives the (dimensionless) electric dipole oscillator strength for the allowed transitions in Na-like ions.
- TABLE VII. Collision Strengths as a Function of Scattered Electron Energy E' for Li-like ions**
 Table VII gives values for the collision strengths from which one can obtain values for the cross sections using Eqs. (15)–(17) or the rate coefficients using Eqs. (23)–(26). 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. (23) has the value $1/137.036$. The Z_{eff} in Eq. (17) is given by Eq. (4) and the transition energy $E_{if}(\text{Ry})$ in Eq. (17) is obtained from the corresponding entry in eV given in Table I by dividing by the conversion factor 13.6057 eV/Ry .

**TABLE VIII. Collision Strengths as a Function
of Scattered Electron Energy E' for F-like ions**

Table VIII gives values for the collision strengths from which one can obtain values for the cross sections using Eqs. (15)–(17) or the rate coefficients using Eqs. (23)–(26). 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. (23) has the value $1/137.036$. The Z_{eff} in Eq. (17) is given by Eq. (5) and the transition energy $E_{if}(\text{Ry})$ in Eq. (17) is obtained from the corresponding entry in eV given in Table II by dividing by the conversion factor 13.6057 eV/Ry .

**TABLE IX. Collision Strengths as a Function
of Scattered Electron Energy E' for Na-like ions**

Table IX gives values for the collision strengths from which one can obtain values for the cross sections using Eqs. (15)–(17) or the rate coefficients using Eqs. (23)–(26). 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. (23) has the value $1/137.036$. The Z_{eff} in Eq. (17) is given by Eq. (7) and the transition energy $E_{if}(\text{Ry})$ in Eq. (17) is obtained from the corresponding entry in eV given in Table III by dividing by the conversion factor 13.6057 eV/Ry .

Z Nuclear charge number

if Initial (lower) and final (upper) levels, labeled according to Eqs. (20)–(22).

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 $Z - 1.66$ [Eq. (4)], or by $Z - 6.667$ [Eq. (5)], or by $Z - 8.34$ [Eq. (7)].

TABLE I. Transition Energies E_{if} (eV) for Li-like Ions

See page 11 for Explanation of Tables

Z	$2s - 2p^*$	$2s - 2p$	$2p^* - 2p$	Z	$2s - 2p^*$	$2s - 2p$	$2p^* - 2p$
26	4.8788E+1	6.4728E+1	1.5939E+1	27	5.0960E+1	6.9735E+1	1.8775E+1
28	5.3152E+1	7.5128E+1	2.1976E+1	29	5.5363E+1	8.0939E+1	2.5576E+1
30	5.7597E+1	8.7202E+1	2.9606E+1	31	5.9852E+1	9.3953E+1	3.4101E+1
32	6.2130E+1	1.0123E+2	3.9098E+1	33	6.4433E+1	1.0907E+2	4.4633E+1
34	6.6761E+1	1.1751E+2	5.0747E+1	35	6.9115E+1	1.2660E+2	5.7480E+1
36	7.1496E+1	1.3637E+2	6.4875E+1	37	7.3905E+1	1.4688E+2	7.2978E+1
38	7.6344E+1	1.5818E+2	8.1833E+1	39	7.8813E+1	1.7030E+2	9.1490E+1
40	8.1313E+1	1.8331E+2	1.0200E+2	41	8.3846E+1	1.9726E+2	1.1341E+2
42	8.6412E+1	2.1220E+2	1.2579E+2	43	8.9013E+1	2.2819E+2	1.3918E+2
44	9.1650E+1	2.4529E+2	1.5364E+2	45	9.4325E+1	2.6357E+2	1.6924E+2
46	9.7037E+1	2.8308E+2	1.8604E+2	47	9.9790E+1	3.0390E+2	2.0411E+2
48	1.0258E+2	3.2609E+2	2.2351E+2	49	1.0542E+2	3.4974E+2	2.4432E+2
50	1.0830E+2	3.7491E+2	2.6662E+2	51	1.1122E+2	4.0169E+2	2.9047E+2
52	1.1419E+2	4.3015E+2	3.1596E+2	53	1.1721E+2	4.6038E+2	3.4317E+2
54	1.2028E+2	4.9247E+2	3.7220E+2	55	1.2340E+2	5.2652E+2	4.0312E+2
56	1.2657E+2	5.6261E+2	4.3604E+2	57	1.2979E+2	6.0084E+2	4.7105E+2
58	1.3308E+2	6.4133E+2	5.0825E+2	59	1.3642E+2	6.8417E+2	5.4775E+2
60	1.3982E+2	7.2948E+2	5.8966E+2	61	1.4329E+2	7.7737E+2	6.3408E+2
62	1.4680E+2	8.2795E+2	6.8115E+2	63	1.5039E+2	8.8136E+2	7.3098E+2
64	1.5403E+2	9.3772E+2	7.8370E+2	65	1.5775E+2	9.9719E+2	8.3944E+2
66	1.6153E+2	1.0599E+3	8.9834E+2	67	1.6538E+2	1.1259E+3	9.6056E+2
68	1.6931E+2	1.1955E+3	1.0262E+3	69	1.7332E+2	1.2688E+3	1.0955E+3
70	1.7738E+2	1.3460E+3	1.1686E+3	71	1.8153E+2	1.4271E+3	1.2456E+3
72	1.8574E+2	1.5125E+3	1.3267E+3	73	1.9005E+2	1.6023E+3	1.4122E+3
74	1.9442E+2	1.6966E+3	1.5022E+3	75	1.9888E+2	1.7957E+3	1.5969E+3
76	2.0339E+2	1.8999E+3	1.6965E+3	77	2.0800E+2	2.0092E+3	1.8012E+3
78	2.1268E+2	2.1240E+3	1.9113E+3	79	2.1746E+2	2.2445E+3	2.0271E+3
80	2.2227E+2	2.3710E+3	2.1487E+3	81	2.2715E+2	2.5036E+3	2.2765E+3
82	2.3211E+2	2.6427E+3	2.4106E+3	83	2.3716E+2	2.7887E+3	2.5515E+3
84	2.4232E+2	2.9418E+3	2.6994E+3	85	2.4752E+2	3.1022E+3	2.8547E+3
86	2.5240E+2	3.2700E+3	3.0176E+3	87	2.5766E+2	3.4462E+3	3.1886E+3
88	2.6287E+2	3.6308E+3	3.3679E+3	89	2.6818E+2	3.8243E+3	3.5561E+3
90	2.7330E+2	4.0268E+3	3.7535E+3	91	2.7869E+2	4.2393E+3	3.9606E+3
92	2.8361E+2	4.4614E+3	4.1778E+3				

TABLE II. Transition Energies E_{if} (eV) for F-like Ions

See page 11 for Explanation of Tables

Z	$2p - 2p^*$	$2p - 2s$	$2p^* - 2s$	Z	$2p - 2p^*$	$2p - 2s$	$2p^* - 2s$
26	1.2698E+1	1.3439E+2	1.2169E+2	27	1.5097E+1	1.4274E+2	1.2765E+2
28	1.7823E+1	1.5146E+2	1.3364E+2	29	2.0907E+1	1.6057E+2	1.3966E+2
30	2.4379E+1	1.7010E+2	1.4572E+2	31	2.8272E+1	1.8009E+2	1.5182E+2
32	3.2619E+1	1.9058E+2	1.5796E+2	33	3.7457E+1	2.0160E+2	1.6415E+2
34	4.2823E+1	2.1320E+2	1.7037E+2	35	4.8755E+1	2.2540E+2	1.7665E+2
36	5.5294E+1	2.3826E+2	1.8297E+2	37	6.2483E+1	2.5182E+2	1.8934E+2
38	7.0366E+1	2.6613E+2	1.9576E+2	39	7.8987E+1	2.8122E+2	2.0224E+2
40	8.8398E+1	2.9717E+2	2.0877E+2	41	9.8645E+1	3.1400E+2	2.1536E+2
42	1.0978E+2	3.3179E+2	2.2201E+2	43	1.2186E+2	3.5058E+2	2.2872E+2
44	1.3494E+2	3.7044E+2	2.3549E+2	45	1.4908E+2	3.9142E+2	2.4233E+2
46	1.6434E+2	4.1359E+2	2.4924E+2	47	1.8079E+2	4.3701E+2	2.5623E+2
48	1.9848E+2	4.6175E+2	2.6328E+2	49	2.1748E+2	4.8789E+2	2.7041E+2
50	2.3788E+2	5.1549E+2	2.7762E+2	51	2.5974E+2	5.4464E+2	2.8490E+2
52	2.8313E+2	5.7540E+2	2.9227E+2	53	3.0815E+2	6.0788E+2	2.9973E+2
54	3.3486E+2	6.4214E+2	3.0728E+2	55	3.6337E+2	6.7829E+2	3.1492E+2
56	3.9375E+2	7.1640E+2	3.2265E+2	57	4.2610E+2	7.5658E+2	3.3048E+2
58	4.6052E+2	7.9893E+2	3.3841E+2	59	4.9711E+2	8.4356E+2	3.4645E+2
60	5.3596E+2	8.9056E+2	3.5459E+2	61	5.7720E+2	9.4005E+2	3.6285E+2
62	6.2094E+2	9.9214E+2	3.7120E+2	63	6.6728E+2	1.0470E+3	3.7968E+2
64	7.1636E+2	1.1046E+3	3.8827E+2	65	7.6831E+2	1.1653E+3	3.9699E+2
66	8.2324E+2	1.2291E+3	4.0584E+2	67	8.8131E+2	1.2961E+3	4.1481E+2
68	9.4266E+2	1.3666E+3	4.2392E+2	69	1.0074E+3	1.4406E+3	4.3317E+2
70	1.0758E+3	1.5183E+3	4.4254E+2	71	1.1479E+3	1.6000E+3	4.5207E+2
72	1.2239E+3	1.6857E+3	4.6174E+2	73	1.3040E+3	1.7756E+3	4.7156E+2
74	1.3884E+3	1.8700E+3	4.8153E+2	75	1.4773E+3	1.9690E+3	4.9165E+2
76	1.5709E+3	2.0728E+3	5.0192E+2	77	1.6693E+3	2.1817E+3	5.1237E+2
78	1.7728E+3	2.2958E+3	5.2297E+2	79	1.8817E+3	2.4155E+3	5.3375E+2
80	1.9962E+3	2.5408E+3	5.4467E+2	81	2.1165E+3	2.6722E+3	5.5574E+2
82	2.2429E+3	2.8099E+3	5.6700E+2	83	2.3757E+3	2.9541E+3	5.7845E+2
84	2.5151E+3	3.1052E+3	5.9012E+2	85	2.6616E+3	3.2635E+3	6.0193E+2
86	2.8153E+3	3.4288E+3	6.1355E+2	87	2.9767E+3	3.6024E+3	6.2567E+2
88	3.1461E+3	3.7839E+3	6.3786E+2	89	3.3238E+3	3.9741E+3	6.5028E+2
90	3.5104E+3	4.1730E+3	6.6265E+2	91	3.7061E+3	4.3815E+3	6.7542E+2
92	3.9114E+3	4.5993E+3	6.8789E+2				

TABLE III. Transition Energies E_{if} (eV) for Na-like Ions

See page 11 for Explanation of Tables

Z	$3s - 3p^*$	$3s - 3p$	$3s - 3d^*$	$3s - 3d$	$3p^* - 3p$	$3p^* - 3d^*$	$3p^* - 3d$	$3p - 3d^*$	$3p - 3d$	$3d^* - 3d$
26	3.4483E+1	3.7068E+1	8.3919E+1	8.4266E+1	2.5853E+0	4.9436E+1	4.9783E+1	4.6851E+1	4.7198E+1	3.4748E-1
27	3.6644E+1	3.9780E+1	8.9476E+1	8.9920E+1	3.1360E+0	5.2832E+1	5.3276E+1	4.9696E+1	5.0140E+1	4.4462E-1
28	3.8814E+1	4.2583E+1	9.5118E+1	9.5678E+1	3.7695E+0	5.6304E+1	5.6865E+1	5.2535E+1	5.3095E+1	5.6027E-1
29	4.0992E+1	4.5487E+1	1.0086E+2	1.0155E+2	4.4944E+0	5.9863E+1	6.0560E+1	5.5369E+1	5.6065E+1	6.9632E-1
30	4.3181E+1	4.8500E+1	1.0670E+2	1.0755E+2	5.3189E+0	6.3519E+1	6.4373E+1	5.8200E+1	5.9055E+1	8.5469E-1
31	4.5380E+1	5.1632E+1	1.1266E+2	1.1370E+2	6.2519E+0	6.7280E+1	6.8318E+1	6.1028E+1	6.2067E+1	1.0381E+0
32	4.7590E+1	5.4894E+1	1.1875E+2	1.2000E+2	7.3034E+0	7.1159E+1	7.2408E+1	6.3856E+1	6.5104E+1	1.2487E+0
33	4.9813E+1	5.8295E+1	1.2498E+2	1.2647E+2	8.4821E+0	7.5165E+1	7.6654E+1	6.6683E+1	6.8172E+1	1.4895E+0
34	5.2048E+1	6.1848E+1	1.3136E+2	1.3312E+2	9.7997E+0	7.9309E+1	8.1072E+1	6.9509E+1	7.1272E+1	1.7627E+0
35	5.4297E+1	6.5563E+1	1.3790E+2	1.3997E+2	1.1266E+1	8.3604E+1	8.5675E+1	7.2338E+1	7.4409E+1	2.0713E+0
36	5.6559E+1	6.9452E+1	1.4462E+2	1.4704E+2	1.2893E+1	8.8061E+1	9.0479E+1	7.5168E+1	7.7586E+1	2.4177E+0
37	5.8837E+1	7.3529E+1	1.5153E+2	1.5433E+2	1.4692E+1	9.2692E+1	9.5498E+1	7.8000E+1	8.0806E+1	2.8057E+0
38	6.1129E+1	7.7805E+1	1.5864E+2	1.6188E+2	1.6676E+1	9.7511E+1	1.0075E+2	8.0835E+1	8.4073E+1	3.2375E+0
39	6.3438E+1	8.2295E+1	1.6597E+2	1.6969E+2	1.8857E+1	1.0253E+2	1.0625E+2	8.3674E+1	8.7391E+1	3.7170E+0
40	6.5764E+1	8.7014E+1	1.7353E+2	1.7778E+2	2.1250E+1	1.0777E+2	1.1201E+2	8.6516E+1	9.0763E+1	4.2473E+0
41	6.8107E+1	9.1974E+1	1.8134E+2	1.8617E+2	2.3867E+1	1.1323E+2	1.1806E+2	8.9362E+1	9.4194E+1	4.8321E+0
42	7.0468E+1	9.7192E+1	1.8940E+2	1.9488E+2	2.6724E+1	1.1894E+2	1.2441E+2	9.2213E+1	9.7687E+1	5.4745E+0
43	7.2848E+1	1.0268E+2	1.9775E+2	2.0393E+2	2.9837E+1	1.2491E+2	1.3108E+2	9.5068E+1	1.0125E+2	6.1785E+0
44	7.5247E+1	1.0847E+2	2.0640E+2	2.1334E+2	3.3220E+1	1.3115E+2	1.3810E+2	9.7929E+1	1.0488E+2	6.9480E+0
45	7.7667E+1	1.1456E+2	2.1535E+2	2.2314E+2	3.6890E+1	1.3769E+2	1.4547E+2	1.0080E+2	1.0858E+2	7.7866E+0
46	8.0107E+1	1.2097E+2	2.2464E+2	2.3334E+2	4.0865E+1	1.4453E+2	1.5323E+2	1.0367E+2	1.1237E+2	8.6990E+0
47	8.2570E+1	1.2773E+2	2.3428E+2	2.4397E+2	4.5163E+1	1.5171E+2	1.6140E+2	1.0655E+2	1.1624E+2	9.6889E+0
48	8.5054E+1	1.3486E+2	2.4429E+2	2.5505E+2	4.9802E+1	1.5923E+2	1.7000E+2	1.0943E+2	1.2019E+2	1.0760E+1
49	8.7562E+1	1.4236E+2	2.5469E+2	2.6661E+2	5.4801E+1	1.6713E+2	1.7905E+2	1.1233E+2	1.2424E+2	1.1919E+1
50	9.0095E+1	1.5028E+2	2.6550E+2	2.7867E+2	6.0181E+1	1.7541E+2	1.8857E+2	1.1523E+2	1.2839E+2	1.3168E+1
51	9.2651E+1	1.5861E+2	2.7675E+2	2.9126E+2	6.5963E+1	1.8410E+2	1.9861E+2	1.1813E+2	1.3264E+2	1.4512E+1
52	9.5233E+1	1.6740E+2	2.8845E+2	3.0441E+2	7.2168E+1	1.9322E+2	2.0917E+2	1.2105E+2	1.3700E+2	1.5957E+1
53	9.7843E+1	1.7666E+2	3.0063E+2	3.1814E+2	7.8820E+1	2.0279E+2	2.2030E+2	1.2397E+2	1.4148E+2	1.7508E+1
54	1.0048E+2	1.8642E+2	3.1332E+2	3.3249E+2	8.5942E+1	2.1284E+2	2.3201E+2	1.2690E+2	1.4607E+2	1.9169E+1
55	1.0314E+2	1.9670E+2	3.2654E+2	3.4749E+2	9.3558E+1	2.2340E+2	2.4434E+2	1.2984E+2	1.5079E+2	2.0945E+1
56	1.0584E+2	2.0753E+2	3.4032E+2	3.6316E+2	1.0169E+2	2.3448E+2	2.5733E+2	1.3279E+2	1.5663E+2	2.2843E+1
57	1.0856E+2	2.1894E+2	3.5468E+2	3.7955E+2	1.1038E+2	2.4612E+2	2.7099E+2	1.3574E+2	1.6061E+2	2.4868E+1
58	1.1132E+2	2.3095E+2	3.6966E+2	3.9669E+2	1.1963E+2	2.5834E+2	2.8537E+2	1.3871E+2	1.6574E+2	2.7025E+1
59	1.1411E+2	2.4360E+2	3.8529E+2	4.1461E+2	1.2949E+2	2.7118E+2	3.0050E+2	1.4169E+2	1.7101E+2	2.9320E+1
60	1.1693E+2	2.5691E+2	4.0158E+2	4.3334E+2	1.3999E+2	2.8466E+2	3.1642E+2	1.4467E+2	1.7643E+2	3.1758E+1
61	1.1978E+2	2.7092E+2	4.1859E+2	4.5294E+2	1.5114E+2	2.9881E+2	3.3316E+2	1.4767E+2	1.8201E+2	3.4347E+1
62	1.2267E+2	2.8566E+2	4.3633E+2	4.7343E+2	1.6299E+2	3.1367E+2	3.5076E+2	1.5067E+2	1.8777E+2	3.7092E+1
63	1.2559E+2	3.0117E+2	4.5486E+2	4.9486E+2	1.7558E+2	3.2927E+2	3.6927E+2	1.5369E+2	1.9369E+2	4.0000E+1
64	1.2855E+2	3.1747E+2	4.7419E+2	5.1727E+2	1.8892E+2	3.4564E+2	3.8872E+2	1.5672E+2	1.9979E+2	4.3076E+1
65	1.3155E+2	3.3462E+2	4.9438E+2	5.4071E+2	2.0307E+2	3.6283E+2	4.0916E+2	1.5975E+2	2.0608E+2	4.6329E+1
66	1.3459E+2	3.5265E+2	5.1545E+2	5.6521E+2	2.1806E+2	3.8086E+2	4.3063E+2	1.6280E+2	2.1257E+2	4.9764E+1
67	1.3767E+2	3.7159E+2	5.3745E+2	5.9084E+2	2.3393E+2	3.9979E+2	4.5318E+2	1.6586E+2	2.1925E+2	5.3389E+1
68	1.4078E+2	3.9150E+2	5.6043E+2	6.1764E+2	2.5072E+2	4.1965E+2	4.7686E+2	1.6893E+2	2.2614E+2	5.7210E+1
69	1.4395E+2	4.1241E+2	5.8443E+2	6.4566E+2	2.6847E+2	4.4048E+2	5.0172E+2	1.7201E+2	2.3325E+2	6.1235E+1
70	1.4715E+2	4.3437E+2	6.0948E+2	6.7495E+2	2.8723E+2	4.6233E+2	5.2781E+2	1.7511E+2	2.4058E+2	6.5472E+1
71	1.5040E+2	4.5744E+2	6.3565E+2	7.0558E+2	3.0704E+2	4.8526E+2	5.5518E+2	1.7822E+2	2.4814E+2	6.9926E+1
72	1.5369E+2	4.8164E+2	6.6298E+2	7.3759E+2	3.2796E+2	5.0929E+2	5.8390E+2	1.8133E+2	2.5594E+2	7.4609E+1
73	1.5702E+2	5.0706E+2	6.9152E+2	7.7105E+2	3.5003E+2	5.3449E+2	6.1402E+2	1.8446E+2	2.6399E+2	7.9526E+1
74	1.6041E+2	5.3372E+2	7.2133E+2	8.0601E+2	3.7331E+2	5.6092E+2	6.4560E+2	1.8761E+2	2.7229E+2	8.4688E+1
75	1.6384E+2	5.6170E+2	7.5246E+2	8.4256E+2	3.9785E+2	5.8862E+2	6.7871E+2	1.9076E+2	2.8086E+2	9.0097E+1
76	1.6732E+2	5.9104E+2	7.8497E+2	8.8074E+2	4.2372E+2	6.1765E+2	7.1342E+2	1.9393E+2	2.8970E+2	9.5768E+1
77	1.7086E+2	6.2182E+2	8.1893E+2	9.2064E+2	4.5096E+2	6.4807E+2	7.4978E+2	1.9711E+2	2.9882E+2	1.0171E+2
78	1.7444E+2	6.5409E+2	8.5440E+2	9.6232E+2	4.7965E+2	6.7996E+2	7.8788E+2	2.0031E+2	3.0823E+2	1.0792E+2
79	1.7807E+2	6.8793E+2	8.9144E+2	1.0059E+3	5.0985E+2	7.1337E+2	8.2779E+2	2.0352E+2	3.1794E+2	1.1442E+2
80	1.8175E+2	7.2339E+2	9.3012E+2	1.0513E+3	5.4163E+2	7.4837E+2	8.6959E+2	2.0674E+2	3.2796E+2	1.2122E+2
81	1.8548E+2	7.6055E+2	9.7052E+2	1.0988E+3	5.7507E+2	7.8504E+2	9.1336E+2	2.0997E+2	3.3829E+2	1.2832E+2
82	1.8927E+2	7.9950E+2	1.0127E+3	1.1485E+3	6.1023E+2	8.2345E+2	9.5919E+2	2.1322E+2	3.4896E+2	1.3573E+2
83	1.9311E+2	8.4032E+2	1.0568E+3	1.2003E+3	6.4720E+2	8.6369E+2	1.0072E+3	2.1649E+2	3.5996E+2	1.4347E+2
84	1.9703E+2	8.8310E+2	1.1029E+3	1.2544E+3	6.8607E+2	9.0583E+2	1.0574E+3	2.1976E+2	3.7130E+2	1.5154E+2
85	2.0098E+2	9.2790E+2	1.1510E+3	1.3109E+3	7.2691E+2	9.4997E+2	1.1099E+3	2.2305E+2	3.8301E+2	1.5996E+2
86	2.0490E+2	9.7472E+2	1.2011E+3	1.3698E+3	7.6982E+2	9.9618E+2	1.1649E+3	2.2636E+2	3.9508E+2	1.6872E+2
87	2.0895E+2	1.0239E+3	1.2535E+3	1.4314E+3	8.1491E+2	1.0446E+3	1.2224E+3	2.2968E+2	4.0753E+2	1.7785E+2
88	2.1303E+2	1.0753E+3	1.3083E+3	1.4957E+3	8.6227E+2	1.0953E+3	1.2826E+3	2.3301E+2	4.2038E+2	1.8736E+2
89	2.1718E+2	1.1292E+3	1.3655E+3	1.5628E+3	9.1200E+2	1.1484E+3	1.3456E+3	2.3636E+2	4.3362E+2	1.9726E+2
90	2.2133E+2	1.1856E+3	1.4253E+3	1.6328E+3	9.6422E+2	1.2039E+3	1.4115E+3	2.3972E+2	4.4727E+2	2.0755E+2
91	2.2560E+2	1.2447E+3	1.4878E+3	1.7060E+3	1.0191E+3	1.2622E+3	1.4804E+3	2.4309E+2	4.6135E+2	2.1825E+2
92	2.2978E+2	1.3064E+3	1.5529E+3	1.7823E+3	1.0766E+3	1.3231E+3	1.5525E+3	2.4648E+2	4.7586E+2	2.2938E+2

TABLE IV. Electric Dipole Oscillator Strengths for Li-like Ions

See page 11 for Explanation of Tables

Z	$2s - 2p^*$	$2s - 2p$	Z	$2s - 2p^*$	$2s - 2p$
26	1.7730E-2	4.7794E-2	27	1.7045E-2	4.7454E-2
28	1.6412E-2	4.7262E-2	29	1.5825E-2	4.7206E-2
30	1.5281E-2	4.7276E-2	31	1.4774E-2	4.7464E-2
32	1.4301E-2	4.7764E-2	33	1.3858E-2	4.8168E-2
34	1.3443E-2	4.8671E-2	35	1.3053E-2	4.9268E-2
36	1.2686E-2	4.9956E-2	37	1.2340E-2	5.0731E-2
38	1.2014E-2	5.1589E-2	39	1.1705E-2	5.2528E-2
40	1.1412E-2	5.3545E-2	41	1.1135E-2	5.4638E-2
42	1.0871E-2	5.5805E-2	43	1.0621E-2	5.7044E-2
44	1.0382E-2	5.8354E-2	45	1.0155E-2	5.9733E-2
46	9.9381E-3	6.1181E-2	47	9.7310E-3	6.2696E-2
48	9.5326E-3	6.4277E-2	49	9.3429E-3	6.5923E-2
50	9.1610E-3	6.7635E-2	51	8.9867E-3	6.9410E-2
52	8.8190E-3	7.1249E-2	53	8.6586E-3	7.3153E-2
54	8.5038E-3	7.5118E-2	55	8.3551E-3	7.7147E-2
56	8.2116E-3	7.9238E-2	57	8.0736E-3	8.1391E-2
58	7.9406E-3	8.3607E-2	59	7.8122E-3	8.5886E-2
60	7.6878E-3	8.8225E-2	61	7.5679E-3	9.0628E-2
62	7.4510E-3	9.3091E-2	63	7.3385E-3	9.5618E-2
64	7.2287E-3	9.8206E-2	65	7.1229E-3	1.0086E-1
66	7.0197E-3	1.0357E-1	67	6.9196E-3	1.0635E-1
68	6.8223E-3	1.0919E-1	69	6.7277E-3	1.1209E-1
70	6.6348E-3	1.1506E-1	71	6.5447E-3	1.1809E-1
72	6.4562E-3	1.2119E-1	73	6.3700E-3	1.2435E-1
74	6.2853E-3	1.2757E-1	75	6.2026E-3	1.3086E-1
76	6.1206E-3	1.3422E-1	77	6.0407E-3	1.3764E-1
78	5.9617E-3	1.4113E-1	79	5.8842E-3	1.4468E-1
80	5.8067E-3	1.4830E-1	81	5.7298E-3	1.5199E-1
82	5.6540E-3	1.5575E-1	83	5.5792E-3	1.5957E-1
84	5.5058E-3	1.6347E-1	85	5.4321E-3	1.6744E-1
86	5.3504E-3	1.7145E-1	87	5.2760E-3	1.7555E-1
88	5.1996E-3	1.7972E-1	89	5.1242E-3	1.8396E-1
90	5.0443E-3	1.8826E-1	91	4.9688E-3	1.9265E-1
92	4.8840E-3	1.9708E-1			

TABLE V. Electric Dipole Oscillator Strengths for F-like Ions

See page 11 for Explanation of Tables

Z	$2p - 2s$	$2p^* - 2s$	Z	$2p - 2s$	$2p^* - 2s$
26	6.0505E-2	5.3943E-2	27	5.8755E-2	5.1662E-2
28	5.7209E-2	4.9564E-2	29	5.5846E-2	4.7627E-2
30	5.4648E-2	4.5834E-2	31	5.3599E-2	4.4169E-2
32	5.2687E-2	4.2618E-2	33	5.1900E-2	4.1171E-2
34	5.1228E-2	3.9817E-2	35	5.0663E-2	3.8548E-2
36	5.0196E-2	3.7356E-2	37	4.9822E-2	3.6233E-2
38	4.9534E-2	3.5175E-2	39	4.9328E-2	3.4175E-2
40	4.9197E-2	3.3229E-2	41	4.9140E-2	3.2332E-2
42	4.9150E-2	3.1481E-2	43	4.9226E-2	3.0672E-2
44	4.9365E-2	2.9902E-2	45	4.9564E-2	2.9169E-2
46	4.9819E-2	2.8469E-2	47	5.0131E-2	2.7801E-2
48	5.0495E-2	2.7162E-2	49	5.0911E-2	2.6550E-2
50	5.1376E-2	2.5964E-2	51	5.1891E-2	2.5402E-2
52	5.2452E-2	2.4862E-2	53	5.3060E-2	2.4343E-2
54	5.3713E-2	2.3844E-2	55	5.4410E-2	2.3364E-2
56	5.5150E-2	2.2901E-2	57	5.5932E-2	2.2454E-2
58	5.6757E-2	2.2024E-2	59	5.7622E-2	2.1608E-2
60	5.8528E-2	2.1206E-2	61	5.9474E-2	2.0817E-2
62	6.0459E-2	2.0441E-2	63	6.1484E-2	2.0076E-2
64	6.2546E-2	1.9722E-2	65	6.3648E-2	1.9379E-2
66	6.4788E-2	1.9046E-2	67	6.5965E-2	1.8722E-2
68	6.7181E-2	1.8408E-2	69	6.8434E-2	1.8102E-2
70	6.9724E-2	1.7803E-2	71	7.1052E-2	1.7513E-2
72	7.2416E-2	1.7230E-2	73	7.3817E-2	1.6953E-2
74	7.5256E-2	1.6684E-2	75	7.6731E-2	1.6420E-2
76	7.8242E-2	1.6161E-2	77	7.9791E-2	1.5909E-2
78	8.1377E-2	1.5661E-2	79	8.3000E-2	1.5419E-2
80	8.4658E-2	1.5180E-2	81	8.6353E-2	1.4946E-2
82	8.8085E-2	1.4715E-2	83	8.9855E-2	1.4489E-2
84	9.1663E-2	1.4267E-2	85	9.3507E-2	1.4048E-2
86	9.5378E-2	1.3823E-2	87	9.7295E-2	1.3609E-2
88	9.9246E-2	1.3394E-2	89	1.0124E-1	1.3184E-2
90	1.0326E-1	1.2970E-2	91	1.0533E-1	1.2764E-2
92	1.0742E-1	1.2550E-2			

TABLE VI. Electric Dipole Oscillator Strengths for Na-like Ions

See page 11 for Explanation of Tables

Z	$3s - 3p^*$	$3s - 3p$	$3p^* - 3d^*$	$3p - 3d^*$	$3p - 3d$
26	1.2515E-1	2.7109E-1	2.9401E-1	2.7898E-2	2.5355E-1
27	1.1970E-1	2.6203E-1	2.7930E-1	2.6300E-2	2.3947E-1
28	1.1470E-1	2.5395E-1	2.6633E-1	2.4872E-2	2.2693E-1
29	1.1010E-1	2.4675E-1	2.5484E-1	2.3587E-2	2.1569E-1
30	1.0585E-1	2.4033E-1	2.4464E-1	2.2426E-2	2.0558E-1
31	1.0192E-1	2.3463E-1	2.3555E-1	2.1372E-2	1.9644E-1
32	9.8274E-2	2.2956E-1	2.2744E-1	2.0410E-2	1.8816E-1
33	9.4880E-2	2.2508E-1	2.2019E-1	1.9530E-2	1.8062E-1
34	9.1714E-2	2.2113E-1	2.1371E-1	1.8722E-2	1.7373E-1
35	8.8754E-2	2.1768E-1	2.0792E-1	1.7977E-2	1.6743E-1
36	8.5981E-2	2.1468E-1	2.0273E-1	1.7289E-2	1.6165E-1
37	8.3377E-2	2.1210E-1	1.9810E-1	1.6650E-2	1.5633E-1
38	8.0928E-2	2.0991E-1	1.9398E-1	1.6057E-2	1.5143E-1
39	7.8621E-2	2.0808E-1	1.9030E-1	1.5503E-2	1.4691E-1
40	7.6443E-2	2.0660E-1	1.8705E-1	1.4986E-2	1.4273E-1
41	7.4384E-2	2.0543E-1	1.8419E-1	1.4502E-2	1.3886E-1
42	7.2434E-2	2.0458E-1	1.8167E-1	1.4048E-2	1.3527E-1
43	7.0586E-2	2.0400E-1	1.7949E-1	1.3622E-2	1.3193E-1
44	6.8832E-2	2.0370E-1	1.7761E-1	1.3220E-2	1.2884E-1
45	6.7164E-2	2.0367E-1	1.7602E-1	1.2840E-2	1.2596E-1
46	6.5576E-2	2.0388E-1	1.7470E-1	1.2482E-2	1.2328E-1
47	6.4064E-2	2.0432E-1	1.7362E-1	1.2143E-2	1.2079E-1
48	6.2620E-2	2.0500E-1	1.7279E-1	1.1821E-2	1.1848E-1
49	6.1242E-2	2.0589E-1	1.7218E-1	1.1516E-2	1.1632E-1
50	5.9924E-2	2.0700E-1	1.7178E-1	1.1226E-2	1.1432E-1
51	5.8664E-2	2.0831E-1	1.7159E-1	1.0950E-2	1.1245E-1
52	5.7455E-2	2.0982E-1	1.7159E-1	1.0687E-2	1.1071E-1
53	5.6298E-2	2.1153E-1	1.7178E-1	1.0436E-2	1.0910E-1
54	5.5187E-2	2.1342E-1	1.7215E-1	1.0197E-2	1.0760E-1
55	5.4120E-2	2.1549E-1	1.7269E-1	9.9680E-3	1.0621E-1
56	5.3095E-2	2.1775E-1	1.7340E-1	9.7490E-3	1.0493E-1
57	5.2108E-2	2.2018E-1	1.7427E-1	9.5391E-3	1.0374E-1
58	5.1159E-2	2.2279E-1	1.7530E-1	9.3380E-3	1.0264E-1
59	5.0245E-2	2.2556E-1	1.7648E-1	9.1449E-3	1.0163E-1
60	4.9363E-2	2.2850E-1	1.7781E-1	8.9595E-3	1.0070E-1
61	4.8513E-2	2.3161E-1	1.7928E-1	8.7813E-3	9.9849E-2
62	4.7690E-2	2.3487E-1	1.8091E-1	8.6099E-3	9.9074E-2
63	4.6897E-2	2.3830E-1	1.8266E-1	8.4449E-3	9.8370E-2
64	4.6129E-2	2.4188E-1	1.8456E-1	8.2859E-3	9.7735E-2
65	4.5387E-2	2.4562E-1	1.8660E-1	8.1326E-3	9.7165E-2
66	4.4669E-2	2.4952E-1	1.8877E-1	7.9847E-3	9.6657E-2
67	4.3973E-2	2.5357E-1	1.9107E-1	7.8420E-3	9.6210E-2
68	4.3298E-2	2.5778E-1	1.9351E-1	7.7041E-3	9.5820E-2
69	4.2645E-2	2.6213E-1	1.9608E-1	7.5708E-3	9.5486E-2
70	4.2009E-2	2.6664E-1	1.9878E-1	7.4418E-3	9.5205E-2
71	4.1393E-2	2.7130E-1	2.0160E-1	7.3170E-3	9.4976E-2
72	4.0793E-2	2.7611E-1	2.0456E-1	7.1962E-3	9.4796E-2
73	4.0210E-2	2.8107E-1	2.0765E-1	7.0791E-3	9.4664E-2
74	3.9643E-2	2.8618E-1	2.1087E-1	6.9656E-3	9.4578E-2
75	3.9090E-2	2.9144E-1	2.1422E-1	6.8555E-3	9.4538E-2
76	3.8551E-2	2.9685E-1	2.1770E-1	6.7486E-3	9.4541E-2
77	3.8026E-2	3.0241E-1	2.2131E-1	6.6449E-3	9.4587E-2
78	3.7513E-2	3.0811E-1	2.2505E-1	6.5441E-3	9.4673E-2
79	3.7013E-2	3.1397E-1	2.2893E-1	6.4462E-3	9.4799E-2
80	3.6522E-2	3.1997E-1	2.3294E-1	6.3509E-3	9.4964E-2
81	3.6041E-2	3.2612E-1	2.3708E-1	6.2583E-3	9.5167E-2
82	3.5571E-2	3.3242E-1	2.4136E-1	6.1681E-3	9.5406E-2
83	3.5112E-2	3.3888E-1	2.4578E-1	6.0804E-3	9.5681E-2
84	3.4663E-2	3.4548E-1	2.5033E-1	5.9948E-3	9.5992E-2
85	3.4220E-2	3.5224E-1	2.5502E-1	5.9115E-3	9.6336E-2
86	3.3770E-2	3.5911E-1	2.5986E-1	5.8303E-3	9.6714E-2
87	3.3340E-2	3.6616E-1	2.6484E-1	5.7510E-3	9.7125E-2
88	3.2913E-2	3.7335E-1	2.6997E-1	5.6737E-3	9.7567E-2
89	3.2495E-2	3.8070E-1	2.7524E-1	5.5982E-3	9.8041E-2
90	3.2074E-2	3.8817E-1	2.8066E-1	5.5245E-3	9.8545E-2
91	3.1667E-2	3.9583E-1	2.8624E-1	5.4525E-3	9.9080E-2
92	3.1247E-2	4.0359E-1	2.9197E-1	5.3821E-3	9.9644E-2

TABLE VII. Collision Strengths as a Function of Scattered Electron Energy E' for Li-like ions

See page 11 for Explanation of Tables

$2s - 2p^*$							$2s - 2p$						
Z	$E'=0.008$	$E'=0.04$	$E'=0.10$	$E'=0.21$	$E'=0.41$	$E'=0.75$	Z	$E'=0.008$	$E'=0.04$	$E'=0.10$	$E'=0.21$	$E'=0.41$	$E'=0.75$
26	1.63E-1	1.84E-1	2.14E-1	2.48E-1	2.85E-1	3.22E-1	26	3.06E-1	3.47E-1	4.06E-1	4.70E-1	5.38E-1	6.09E-1
27	1.51E-1	1.71E-1	1.99E-1	2.31E-1	2.66E-1	2.99E-1	27	2.83E-1	3.21E-1	3.74E-1	4.34E-1	4.98E-1	5.63E-1
28	1.40E-1	1.59E-1	1.85E-1	2.15E-1	2.48E-1	2.79E-1	28	2.62E-1	2.97E-1	3.46E-1	4.02E-1	4.61E-1	5.22E-1
29	1.31E-1	1.48E-1	1.73E-1	2.01E-1	2.32E-1	2.61E-1	29	2.44E-1	2.76E-1	3.20E-1	3.73E-1	4.28E-1	4.85E-1
30	1.22E-1	1.39E-1	1.62E-1	1.88E-1	2.17E-1	2.45E-1	30	2.27E-1	2.58E-1	2.97E-1	3.47E-1	3.98E-1	4.51E-1
31	1.14E-1	1.30E-1	1.51E-1	1.77E-1	2.04E-1	2.30E-1	31	2.12E-1	2.40E-1	2.77E-1	3.23E-1	3.71E-1	4.21E-1
32	1.07E-1	1.22E-1	1.42E-1	1.66E-1	1.92E-1	2.16E-1	32	1.99E-1	2.25E-1	2.58E-1	3.01E-1	3.46E-1	3.94E-1
33	1.00E-1	1.15E-1	1.34E-1	1.57E-1	1.80E-1	2.04E-1	33	1.86E-1	2.11E-1	2.40E-1	2.81E-1	3.24E-1	3.68E-1
34	9.43E-2	1.08E-1	1.26E-1	1.48E-1	1.70E-1	1.93E-1	34	1.74E-1	1.98E-1	2.25E-1	2.63E-1	3.03E-1	3.45E-1
35	8.89E-2	1.02E-1	1.19E-1	1.40E-1	1.61E-1	1.82E-1	35	1.63E-1	1.86E-1	2.10E-1	2.47E-1	2.84E-1	3.24E-1
36	8.39E-2	9.63E-2	1.13E-1	1.32E-1	1.53E-1	1.73E-1	36	1.53E-1	1.74E-1	1.97E-1	2.32E-1	2.67E-1	3.05E-1
37	7.93E-2	9.11E-2	1.07E-1	1.25E-1	1.45E-1	1.64E-1	37	1.43E-1	1.64E-1	1.85E-1	2.17E-1	2.51E-1	2.87E-1
38	7.50E-2	8.63E-2	1.01E-1	1.19E-1	1.37E-1	1.56E-1	38	1.35E-1	1.53E-1	1.74E-1	2.04E-1	2.37E-1	2.70E-1
39	7.10E-2	8.18E-2	9.60E-2	1.13E-1	1.31E-1	1.48E-1	39	1.27E-1	1.44E-1	1.64E-1	1.92E-1	2.23E-1	2.55E-1
40	6.74E-2	7.77E-2	9.13E-2	1.07E-1	1.24E-1	1.41E-1	40	1.20E-1	1.35E-1	1.55E-1	1.81E-1	2.10E-1	2.41E-1
41	6.40E-2	7.38E-2	8.69E-2	1.02E-1	1.18E-1	1.35E-1	41	1.14E-1	1.28E-1	1.47E-1	1.71E-1	1.99E-1	2.28E-1
42	6.09E-2	7.03E-2	8.28E-2	9.76E-2	1.13E-1	1.29E-1	42	1.08E-1	1.20E-1	1.39E-1	1.62E-1	1.88E-1	2.16E-1
43	5.80E-2	6.69E-2	7.89E-2	9.31E-2	1.08E-1	1.23E-1	43	1.02E-1	1.14E-1	1.31E-1	1.53E-1	1.78E-1	2.05E-1
44	5.52E-2	6.38E-2	7.53E-2	8.89E-2	1.03E-1	1.17E-1	44	9.67E-2	1.08E-1	1.24E-1	1.44E-1	1.68E-1	1.94E-1
45	5.26E-2	6.09E-2	7.20E-2	8.50E-2	9.86E-2	1.13E-1	45	9.16E-2	1.03E-1	1.18E-1	1.37E-1	1.60E-1	1.84E-1
46	5.03E-2	5.81E-2	6.88E-2	8.13E-2	9.44E-2	1.08E-1	46	8.68E-2	9.79E-2	1.12E-1	1.30E-1	1.51E-1	1.75E-1
47	4.80E-2	5.56E-2	6.58E-2	7.79E-2	9.04E-2	1.03E-1	47	8.26E-2	9.31E-2	1.06E-1	1.23E-1	1.44E-1	1.67E-1
48	4.59E-2	5.32E-2	6.30E-2	7.46E-2	8.67E-2	9.94E-2	48	7.87E-2	8.84E-2	1.01E-1	1.17E-1	1.37E-1	1.59E-1
49	4.39E-2	5.09E-2	6.04E-2	7.15E-2	8.31E-2	9.55E-2	49	7.51E-2	8.39E-2	9.57E-2	1.11E-1	1.30E-1	1.51E-1
50	4.33E-2	4.77E-2	5.71E-2	6.85E-2	7.99E-2	9.18E-2	50	7.12E-2	7.99E-2	9.09E-2	1.06E-1	1.24E-1	1.44E-1
51	4.15E-2	4.57E-2	5.48E-2	6.57E-2	7.68E-2	8.83E-2	51	6.81E-2	7.65E-2	8.63E-2	1.01E-1	1.18E-1	1.37E-1
52	3.98E-2	4.39E-2	5.26E-2	6.31E-2	7.38E-2	8.50E-2	52	6.51E-2	7.32E-2	8.21E-2	9.65E-2	1.13E-1	1.31E-1
53	3.81E-2	4.21E-2	5.06E-2	6.07E-2	7.10E-2	8.19E-2	53	6.23E-2	6.98E-2	7.81E-2	9.19E-2	1.07E-1	1.26E-1
54	3.65E-2	4.05E-2	4.86E-2	5.84E-2	6.83E-2	7.89E-2	54	5.95E-2	6.66E-2	7.45E-2	8.76E-2	1.02E-1	1.20E-1
55	3.51E-2	3.89E-2	4.68E-2	5.62E-2	6.58E-2	7.61E-2	55	5.68E-2	6.34E-2	7.12E-2	8.35E-2	9.79E-2	1.15E-1
56	3.37E-2	3.74E-2	4.50E-2	5.41E-2	6.34E-2	7.34E-2	56	5.43E-2	6.02E-2	6.80E-2	7.97E-2	9.36E-2	1.10E-1
57	3.24E-2	3.60E-2	4.33E-2	5.21E-2	6.11E-2	7.08E-2	57	5.19E-2	5.73E-2	6.51E-2	7.61E-2	8.96E-2	1.05E-1
58	3.11E-2	3.46E-2	4.17E-2	5.02E-2	5.89E-2	6.84E-2	58	4.96E-2	5.46E-2	6.24E-2	7.27E-2	8.57E-2	1.01E-1
59	2.99E-2	3.33E-2	4.02E-2	4.84E-2	5.68E-2	6.61E-2	59	4.75E-2	5.21E-2	5.99E-2	6.94E-2	8.21E-2	9.70E-2
60	2.88E-2	3.21E-2	3.88E-2	4.66E-2	5.49E-2	6.39E-2	60	4.56E-2	4.99E-2	5.74E-2	6.64E-2	7.86E-2	9.31E-2
61	2.77E-2	3.10E-2	3.74E-2	4.50E-2	5.30E-2	6.18E-2	61	4.38E-2	4.80E-2	5.51E-2	6.36E-2	7.53E-2	8.94E-2
62	2.67E-2	2.99E-2	3.61E-2	4.34E-2	5.12E-2	5.98E-2	62	4.21E-2	4.62E-2	5.28E-2	6.09E-2	7.22E-2	8.59E-2
63	2.57E-2	2.88E-2	3.48E-2	4.19E-2	4.94E-2	5.79E-2	63	4.05E-2	4.45E-2	5.06E-2	5.84E-2	6.93E-2	8.26E-2
64	2.47E-2	2.78E-2	3.36E-2	4.05E-2	4.78E-2	5.60E-2	64	3.89E-2	4.29E-2	4.85E-2	5.60E-2	6.64E-2	7.95E-2
65	2.38E-2	2.68E-2	3.24E-2	3.91E-2	4.62E-2	5.43E-2	65	3.72E-2	4.11E-2	4.64E-2	5.38E-2	6.38E-2	7.65E-2
66	2.30E-2	2.59E-2	3.14E-2	3.78E-2	4.47E-2	5.26E-2	66	3.57E-2	3.94E-2	4.44E-2	5.17E-2	6.13E-2	7.36E-2
67	2.21E-2	2.50E-2	3.03E-2	3.65E-2	4.32E-2	5.10E-2	67	3.44E-2	3.77E-2	4.26E-2	4.97E-2	5.89E-2	7.09E-2
68	2.14E-2	2.42E-2	2.93E-2	3.53E-2	4.18E-2	4.94E-2	68	3.31E-2	3.61E-2	4.08E-2	4.78E-2	5.66E-2	6.83E-2
69	2.06E-2	2.34E-2	2.83E-2	3.42E-2	4.05E-2	4.79E-2	69	3.20E-2	3.46E-2	3.92E-2	4.59E-2	5.44E-2	6.58E-2
70	1.99E-2	2.26E-2	2.74E-2	3.31E-2	3.92E-2	4.65E-2	70	3.08E-2	3.33E-2	3.77E-2	4.42E-2	5.24E-2	6.34E-2
71	1.92E-2	2.18E-2	2.65E-2	3.20E-2	3.80E-2	4.51E-2	71	2.95E-2	3.22E-2	3.64E-2	4.25E-2	5.04E-2	6.12E-2
72	1.85E-2	2.11E-2	2.56E-2	3.09E-2	3.68E-2	4.38E-2	72	2.84E-2	3.11E-2	3.50E-2	4.09E-2	4.86E-2	5.90E-2
73	1.79E-2	2.04E-2	2.48E-2	3.00E-2	3.57E-2	4.25E-2	73	2.74E-2	3.00E-2	3.38E-2	3.93E-2	4.68E-2	5.70E-2
74	1.73E-2	1.98E-2	2.40E-2	2.90E-2	3.46E-2	4.13E-2	74	2.65E-2	2.88E-2	3.25E-2	3.78E-2	4.52E-2	5.50E-2
75	1.67E-2	1.91E-2	2.32E-2	2.81E-2	3.35E-2	4.01E-2	75	2.55E-2	2.77E-2	3.13E-2	3.63E-2	4.36E-2	5.32E-2
76	1.61E-2	1.85E-2	2.25E-2	2.72E-2	3.25E-2	3.89E-2	76	2.45E-2	2.66E-2	3.01E-2	3.50E-2	4.20E-2	5.14E-2
77	1.46E-2	1.73E-2	2.18E-2	2.65E-2	3.16E-2	3.79E-2	77	2.38E-2	2.54E-2	2.90E-2	3.36E-2	4.06E-2	4.98E-2
78	1.42E-2	1.67E-2	2.11E-2	2.56E-2	3.07E-2	3.69E-2	78	2.28E-2	2.45E-2	2.81E-2	3.23E-2	3.92E-2	4.82E-2
79	1.38E-2	1.62E-2	2.04E-2	2.49E-2	2.97E-2	3.58E-2	79	2.20E-2	2.36E-2	2.71E-2	3.12E-2	3.78E-2	4.66E-2
80	1.33E-2	1.57E-2	1.98E-2	2.41E-2	2.89E-2	3.48E-2	80	2.12E-2	2.29E-2	2.62E-2	3.01E-2	3.65E-2	4.51E-2
81	1.29E-2	1.52E-2	1.92E-2	2.33E-2	2.80E-2	3.39E-2	81	2.04E-2	2.22E-2	2.52E-2	2.90E-2	3.52E-2	4.36E-2
82	1.26E-2	1.47E-2	1.86E-2	2.26E-2	2.72E-2	3.29E-2	82	1.98E-2	2.16E-2	2.43E-2	2.80E-2	3.40E-2	4.22E-2
83	1.22E-2	1.43E-2	1.80E-2	2.19E-2	2.64E-2	3.20E-2	83	1.92E-2	2.09E-2	2.33E-2	2.71E-2	3.28E-2	4.09E-2
84	1.18E-2	1.38E-2	1.74E-2	2.13E-2	2.56E-2	3.12E-2	84	1.86E-2	2.02E-2	2.25E-2	2.62E-2	3.16E-2	3.96E-2
85	1.15E-2	1.34E-2	1.69E-2	2.06E-2	2.48E-2	3.03E-2	85	1.80E-2	1.94E-2	2.16E-2	2.53E-2	3.06E-2	3.83E-2
86	1.12E-2	1.30E-2	1.63E-2	2.00E-2	2.41E-2	2.95E-2	86	1.73E-2	1.87E-2	2.08E-2	2.45E-2	2.95E-2	3.71E-2
87	1.09E-2	1.26E-2	1.58E-2	1.94E-2	2.34E-2	2.87E-2	87	1.67E-2	1.80E-2	2.00E-2	2.37E-2	2.86E-2	3.59E-2
88	1.06E-2	1.22E-2	1.54E-2	1.88E-2	2.27E-2	2.79E-2	88	1.60E-2	1.73E-2	1.94E-2	2.29E-2	2.76E-2	3.48E-2
89	1.02E-2	1.18E-2	1.49E-2	1.82E-2	2.21E-2	2.72E-2	89	1.55E-2	1.67E-2	1.87E-2	2.21E-2	2.67E-2	3.37E-2
90	9.94E-3	1.15E-2	1.44E-2	1.77E-2	2.15E-2	2.64E-2	90	1.50E-2	1.62E-2	1.82E-2	2.13E-2	2.59E-2	3.27E-2
91	9.65E-3	1.11E-2	1.40E-2	1.71E-2	2.08E-2	2.57E-2	91	1.46E-2	1.57E-2	1.76E-2	2.06E-2	2.51E-2	3.17E-2
92	9.36E-3	1.08E-2	1.36E-2	1.66E-2	2.02E-2	2.51E-2	92	1.41E-2	1.52E-2	1.71E-2	1.98E-2	2.43E-2	3.07E-2

TABLE VII. Collision Strengths as a Function of Scattered Electron Energy E' for Li-like ions

See page 11 for Explanation of Tables

$2p^* - 2p$						
Z	$E'=0.008$	$E'=0.04$	$E'=0.10$	$E'=0.21$	$E'=0.41$	$E'=0.75$
26	3.12E-2	2.75E-2	2.32E-2	1.95E-2	1.71E-2	1.62E-2
27	2.87E-2	2.53E-2	2.14E-2	1.79E-2	1.58E-2	1.50E-2
28	2.65E-2	2.34E-2	1.98E-2	1.66E-2	1.46E-2	1.39E-2
29	2.45E-2	2.17E-2	1.83E-2	1.54E-2	1.36E-2	1.29E-2
30	2.27E-2	2.01E-2	1.70E-2	1.43E-2	1.26E-2	1.20E-2
31	2.12E-2	1.87E-2	1.59E-2	1.33E-2	1.18E-2	1.12E-2
32	1.97E-2	1.75E-2	1.48E-2	1.25E-2	1.10E-2	1.05E-2
33	1.84E-2	1.63E-2	1.38E-2	1.17E-2	1.03E-2	9.85E-3
34	1.73E-2	1.53E-2	1.30E-2	1.09E-2	9.68E-3	9.26E-3
35	1.62E-2	1.44E-2	1.22E-2	1.03E-2	9.10E-3	8.72E-3
36	1.52E-2	1.35E-2	1.15E-2	9.69E-3	8.58E-3	8.22E-3
37	1.43E-2	1.27E-2	1.08E-2	9.14E-3	8.10E-3	7.77E-3
38	1.35E-2	1.20E-2	1.02E-2	8.63E-3	7.66E-3	7.36E-3
39	1.27E-2	1.13E-2	9.66E-3	8.17E-3	7.25E-3	6.98E-3
40	1.20E-2	1.07E-2	9.15E-3	7.74E-3	6.88E-3	6.63E-3
41	1.14E-2	1.02E-2	8.67E-3	7.34E-3	6.53E-3	6.30E-3
42	1.08E-2	9.65E-3	8.23E-3	6.97E-3	6.21E-3	6.00E-3
43	1.03E-2	9.17E-3	7.83E-3	6.63E-3	5.91E-3	5.72E-3
44	9.78E-3	8.72E-3	7.45E-3	6.31E-3	5.63E-3	5.45E-3
45	9.30E-3	8.30E-3	7.09E-3	6.02E-3	5.37E-3	5.20E-3
46	8.85E-3	7.91E-3	6.77E-3	5.74E-3	5.13E-3	4.98E-3
47	8.44E-3	7.54E-3	6.46E-3	5.48E-3	4.90E-3	4.77E-3
48	8.06E-3	7.20E-3	6.17E-3	5.24E-3	4.69E-3	4.57E-3
49	7.70E-3	6.88E-3	5.90E-3	5.02E-3	4.49E-3	4.39E-3
50	7.36E-3	6.58E-3	5.64E-3	4.80E-3	4.30E-3	4.21E-3
51	7.04E-3	6.30E-3	5.41E-3	4.60E-3	4.13E-3	4.04E-3
52	6.74E-3	6.04E-3	5.18E-3	4.41E-3	3.96E-3	3.88E-3
53	6.46E-3	5.79E-3	4.97E-3	4.24E-3	3.80E-3	3.74E-3
54	6.19E-3	5.55E-3	4.77E-3	4.07E-3	3.66E-3	3.60E-3
55	5.94E-3	5.33E-3	4.58E-3	3.91E-3	3.52E-3	3.47E-3
56	5.71E-3	5.12E-3	4.41E-3	3.76E-3	3.39E-3	3.34E-3
57	5.48E-3	4.92E-3	4.24E-3	3.62E-3	3.26E-3	3.23E-3
58	5.27E-3	4.73E-3	4.08E-3	3.49E-3	3.14E-3	3.12E-3
59	5.07E-3	4.56E-3	3.93E-3	3.36E-3	3.03E-3	3.01E-3
60	4.88E-3	4.39E-3	3.78E-3	3.24E-3	2.93E-3	2.91E-3
61	4.70E-3	4.22E-3	3.65E-3	3.12E-3	2.82E-3	2.81E-3
62	4.53E-3	4.07E-3	3.52E-3	3.01E-3	2.73E-3	2.72E-3
63	4.36E-3	3.93E-3	3.39E-3	2.91E-3	2.64E-3	2.64E-3
64	4.21E-3	3.79E-3	3.28E-3	2.81E-3	2.55E-3	2.55E-3
65	4.06E-3	3.66E-3	3.16E-3	2.71E-3	2.47E-3	2.47E-3
66	3.92E-3	3.53E-3	3.05E-3	2.62E-3	2.39E-3	2.40E-3
67	3.78E-3	3.41E-3	2.95E-3	2.54E-3	2.31E-3	2.32E-3
68	3.65E-3	3.30E-3	2.85E-3	2.46E-3	2.24E-3	2.26E-3
69	3.53E-3	3.18E-3	2.76E-3	2.38E-3	2.17E-3	2.19E-3
70	3.41E-3	3.08E-3	2.67E-3	2.30E-3	2.10E-3	2.13E-3
71	3.30E-3	2.98E-3	2.59E-3	2.23E-3	2.04E-3	2.07E-3
72	3.19E-3	2.88E-3	2.50E-3	2.16E-3	1.97E-3	2.01E-3
73	3.09E-3	2.79E-3	2.42E-3	2.09E-3	1.92E-3	1.95E-3
74	2.98E-3	2.70E-3	2.35E-3	2.03E-3	1.86E-3	1.90E-3
75	2.89E-3	2.62E-3	2.28E-3	1.97E-3	1.80E-3	1.85E-3
76	2.80E-3	2.53E-3	2.20E-3	1.91E-3	1.75E-3	1.79E-3
77	2.71E-3	2.46E-3	2.14E-3	1.85E-3	1.70E-3	1.75E-3
78	2.63E-3	2.38E-3	2.07E-3	1.79E-3	1.65E-3	1.70E-3
79	2.54E-3	2.31E-3	2.01E-3	1.74E-3	1.60E-3	1.65E-3
80	2.47E-3	2.24E-3	1.95E-3	1.69E-3	1.56E-3	1.61E-3
81	2.39E-3	2.17E-3	1.89E-3	1.64E-3	1.51E-3	1.57E-3
82	2.32E-3	2.10E-3	1.84E-3	1.59E-3	1.47E-3	1.53E-3
83	2.25E-3	2.04E-3	1.78E-3	1.55E-3	1.43E-3	1.49E-3
84	2.18E-3	1.98E-3	1.73E-3	1.50E-3	1.39E-3	1.45E-3
85	2.11E-3	1.92E-3	1.68E-3	1.46E-3	1.35E-3	1.41E-3
86	2.05E-3	1.86E-3	1.63E-3	1.42E-3	1.32E-3	1.38E-3
87	1.99E-3	1.81E-3	1.58E-3	1.38E-3	1.28E-3	1.34E-3
88	1.93E-3	1.76E-3	1.54E-3	1.34E-3	1.25E-3	1.31E-3
89	1.87E-3	1.71E-3	1.50E-3	1.30E-3	1.21E-3	1.28E-3
90	1.82E-3	1.66E-3	1.45E-3	1.27E-3	1.18E-3	1.24E-3
91	1.77E-3	1.61E-3	1.41E-3	1.23E-3	1.15E-3	1.21E-3
92	1.71E-3	1.56E-3	1.37E-3	1.20E-3	1.12E-3	1.18E-3

TABLE VIII. Collision Strengths as a Function of Scattered Electron Energy E' for F-like ions

See page 11 for Explanation of Tables

$2p - 2p^*$							$2p - 2s$						
Z	$E'=0.008$	$E'=0.04$	$E'=0.10$	$E'=0.21$	$E'=0.41$	$E'=0.75$	Z	$E'=0.008$	$E'=0.04$	$E'=0.10$	$E'=0.21$	$E'=0.41$	$E'=0.75$
26	4.60E-2	4.04E-2	3.35E-2	2.68E-2	2.21E-2	2.00E-2	26	3.00E-1	3.24E-1	3.61E-1	4.14E-1	4.73E-1	5.40E-1
27	4.16E-2	3.65E-2	3.03E-2	2.43E-2	2.01E-2	1.82E-2	27	2.77E-1	2.99E-1	3.34E-1	3.83E-1	4.38E-1	5.01E-1
28	3.77E-2	3.32E-2	2.75E-2	2.21E-2	1.84E-2	1.68E-2	28	2.57E-1	2.77E-1	3.10E-1	3.56E-1	4.07E-1	4.65E-1
29	3.44E-2	3.02E-2	2.51E-2	2.03E-2	1.69E-2	1.54E-2	29	2.39E-1	2.58E-1	2.88E-1	3.31E-1	3.79E-1	4.33E-1
30	3.14E-2	2.77E-2	2.30E-2	1.86E-2	1.56E-2	1.43E-2	30	2.23E-1	2.40E-1	2.69E-1	3.09E-1	3.53E-1	4.04E-1
31	2.89E-2	2.54E-2	2.12E-2	1.72E-2	1.44E-2	1.32E-2	31	2.08E-1	2.24E-1	2.51E-1	2.88E-1	3.30E-1	3.77E-1
32	2.66E-2	2.34E-2	1.96E-2	1.59E-2	1.34E-2	1.23E-2	32	1.94E-1	2.09E-1	2.35E-1	2.70E-1	3.09E-1	3.53E-1
33	2.46E-2	2.17E-2	1.81E-2	1.47E-2	1.24E-2	1.15E-2	33	1.82E-1	1.96E-1	2.20E-1	2.53E-1	2.90E-1	3.32E-1
34	2.28E-2	2.01E-2	1.68E-2	1.37E-2	1.16E-2	1.07E-2	34	1.70E-1	1.84E-1	2.06E-1	2.37E-1	2.72E-1	3.12E-1
35	2.12E-2	1.87E-2	1.57E-2	1.28E-2	1.08E-2	1.00E-2	35	1.60E-1	1.73E-1	1.94E-1	2.23E-1	2.56E-1	2.94E-1
36	1.97E-2	1.74E-2	1.46E-2	1.19E-2	1.01E-2	9.41E-3	36	1.50E-1	1.63E-1	1.83E-1	2.10E-1	2.41E-1	2.77E-1
37	1.84E-2	1.63E-2	1.37E-2	1.12E-2	9.52E-3	8.85E-3	37	1.41E-1	1.54E-1	1.72E-1	1.98E-1	2.28E-1	2.61E-1
38	1.72E-2	1.52E-2	1.28E-2	1.05E-2	8.95E-3	8.34E-3	38	1.33E-1	1.45E-1	1.63E-1	1.87E-1	2.15E-1	2.47E-1
39	1.61E-2	1.43E-2	1.20E-2	9.87E-3	8.43E-3	7.87E-3	39	1.26E-1	1.37E-1	1.54E-1	1.77E-1	2.03E-1	2.34E-1
40	1.52E-2	1.34E-2	1.13E-2	9.29E-3	7.95E-3	7.44E-3	40	1.19E-1	1.30E-1	1.46E-1	1.67E-1	1.93E-1	2.22E-1
41	1.43E-2	1.26E-2	1.06E-2	8.77E-3	7.52E-3	7.05E-3	41	1.13E-1	1.23E-1	1.38E-1	1.59E-1	1.82E-1	2.10E-1
42	1.35E-2	1.19E-2	1.00E-2	8.29E-3	7.12E-3	6.68E-3	42	1.07E-1	1.17E-1	1.30E-1	1.50E-1	1.74E-1	1.99E-1
43	1.27E-2	1.13E-2	9.50E-3	7.84E-3	6.75E-3	6.34E-3	43	1.02E-1	1.11E-1	1.23E-1	1.42E-1	1.65E-1	1.90E-1
44	1.20E-2	1.06E-2	8.99E-3	7.43E-3	6.41E-3	6.03E-3	44	9.63E-2	1.05E-1	1.17E-1	1.35E-1	1.57E-1	1.80E-1
45	1.14E-2	1.01E-2	8.53E-3	7.06E-3	6.09E-3	5.75E-3	45	9.15E-2	9.95E-2	1.11E-1	1.28E-1	1.49E-1	1.72E-1
46	1.08E-2	9.57E-3	8.09E-3	6.71E-3	5.79E-3	5.48E-3	46	8.69E-2	9.42E-2	1.06E-1	1.22E-1	1.42E-1	1.64E-1
47	1.02E-2	9.09E-3	7.69E-3	6.38E-3	5.52E-3	5.23E-3	47	8.25E-2	8.94E-2	1.01E-1	1.16E-1	1.35E-1	1.56E-1
48	9.70E-3	8.64E-3	7.32E-3	6.07E-3	5.26E-3	5.00E-3	48	7.84E-2	8.49E-2	9.63E-2	1.11E-1	1.29E-1	1.49E-1
49	9.23E-3	8.22E-3	6.97E-3	5.79E-3	5.03E-3	4.78E-3	49	7.46E-2	8.08E-2	9.20E-2	1.05E-1	1.23E-1	1.42E-1
50	8.78E-3	7.83E-3	6.64E-3	5.53E-3	4.80E-3	4.57E-3	50	7.11E-2	7.70E-2	8.78E-2	1.00E-1	1.17E-1	1.36E-1
51	8.37E-3	7.47E-3	6.34E-3	5.28E-3	4.60E-3	4.38E-3	51	6.78E-2	7.35E-2	8.39E-2	9.57E-2	1.12E-1	1.30E-1
52	7.98E-3	7.13E-3	6.05E-3	5.05E-3	4.40E-3	4.20E-3	52	6.48E-2	7.04E-2	8.02E-2	9.14E-2	1.07E-1	1.25E-1
53	7.62E-3	6.81E-3	5.79E-3	4.83E-3	4.22E-3	4.04E-3	53	6.21E-2	6.74E-2	7.67E-2	8.73E-2	1.02E-1	1.19E-1
54	7.28E-3	6.51E-3	5.54E-3	4.63E-3	4.04E-3	3.88E-3	54	5.95E-2	6.47E-2	7.33E-2	8.35E-2	9.79E-2	1.14E-1
55	6.96E-3	6.23E-3	5.30E-3	4.43E-3	3.88E-3	3.73E-3	55	5.70E-2	6.21E-2	7.01E-2	7.99E-2	9.37E-2	1.10E-1
56	6.67E-3	5.96E-3	5.08E-3	4.26E-3	3.73E-3	3.59E-3	56	5.46E-2	5.96E-2	6.69E-2	7.65E-2	8.97E-2	1.05E-1
57	6.39E-3	5.72E-3	4.88E-3	4.08E-3	3.58E-3	3.46E-3	57	5.23E-2	5.72E-2	6.40E-2	7.33E-2	8.59E-2	1.01E-1
58	6.12E-3	5.48E-3	4.68E-3	3.92E-3	3.45E-3	3.33E-3	58	5.00E-2	5.48E-2	6.12E-2	7.03E-2	8.23E-2	9.70E-2
59	5.87E-3	5.26E-3	4.49E-3	3.77E-3	3.31E-3	3.21E-3	59	4.78E-2	5.24E-2	5.85E-2	6.74E-2	7.89E-2	9.32E-2
60	5.64E-3	5.05E-3	4.32E-3	3.63E-3	3.19E-3	3.10E-3	60	4.58E-2	5.00E-2	5.59E-2	6.47E-2	7.57E-2	8.96E-2
61	5.41E-3	4.85E-3	4.15E-3	3.49E-3	3.08E-3	2.99E-3	61	4.39E-2	4.78E-2	5.36E-2	6.21E-2	7.27E-2	8.61E-2
62	5.20E-3	4.67E-3	4.00E-3	3.36E-3	2.97E-3	2.89E-3	62	4.23E-2	4.57E-2	5.13E-2	5.97E-2	6.98E-2	8.29E-2
63	5.00E-3	4.49E-3	3.85E-3	3.24E-3	2.86E-3	2.79E-3	63	4.07E-2	4.39E-2	4.93E-2	5.73E-2	6.71E-2	7.98E-2
64	4.81E-3	4.32E-3	3.70E-3	3.12E-3	2.76E-3	2.70E-3	64	3.92E-2	4.21E-2	4.74E-2	5.51E-2	6.45E-2	7.68E-2
65	4.63E-3	4.16E-3	3.57E-3	3.01E-3	2.67E-3	2.61E-3	65	3.76E-2	4.06E-2	4.56E-2	5.29E-2	6.20E-2	7.40E-2
66	4.46E-3	4.01E-3	3.44E-3	2.91E-3	2.58E-3	2.53E-3	66	3.61E-2	3.92E-2	4.39E-2	5.08E-2	5.97E-2	7.13E-2
67	4.30E-3	3.86E-3	3.32E-3	2.81E-3	2.49E-3	2.45E-3	67	3.46E-2	3.77E-2	4.23E-2	4.88E-2	5.75E-2	6.87E-2
68	4.14E-3	3.73E-3	3.20E-3	2.71E-3	2.41E-3	2.37E-3	68	3.33E-2	3.64E-2	4.07E-2	4.69E-2	5.53E-2	6.62E-2
69	4.00E-3	3.60E-3	3.09E-3	2.62E-3	2.33E-3	2.30E-3	69	3.21E-2	3.49E-2	3.92E-2	4.51E-2	5.33E-2	6.39E-2
70	3.85E-3	3.47E-3	2.99E-3	2.53E-3	2.25E-3	2.23E-3	70	3.10E-2	3.35E-2	3.77E-2	4.33E-2	5.14E-2	6.17E-2
71	3.72E-3	3.35E-3	2.89E-3	2.45E-3	2.18E-3	2.16E-3	71	2.99E-2	3.22E-2	3.62E-2	4.17E-2	4.96E-2	5.95E-2
72	3.59E-3	3.24E-3	2.79E-3	2.37E-3	2.11E-3	2.10E-3	72	2.87E-2	3.09E-2	3.48E-2	4.01E-2	4.78E-2	5.75E-2
73	3.47E-3	3.13E-3	2.70E-3	2.29E-3	2.05E-3	2.04E-3	73	2.76E-2	2.98E-2	3.34E-2	3.86E-2	4.61E-2	5.56E-2
74	3.35E-3	3.02E-3	2.61E-3	2.22E-3	1.98E-3	1.98E-3	74	2.66E-2	2.88E-2	3.21E-2	3.72E-2	4.45E-2	5.37E-2
75	3.24E-3	2.92E-3	2.52E-3	2.15E-3	1.92E-3	1.92E-3	75	2.57E-2	2.74E-2	3.14E-2	3.57E-2	4.29E-2	5.21E-2
76	3.13E-3	2.83E-3	2.44E-3	2.08E-3	1.86E-3	1.87E-3	76	2.47E-2	2.65E-2	3.02E-2	3.44E-2	4.14E-2	5.04E-2
77	3.03E-3	2.74E-3	2.36E-3	2.01E-3	1.81E-3	1.81E-3	77	2.38E-2	2.57E-2	2.91E-2	3.32E-2	3.99E-2	4.87E-2
78	2.93E-3	2.65E-3	2.29E-3	1.95E-3	1.76E-3	1.76E-3	78	2.30E-2	2.49E-2	2.81E-2	3.21E-2	3.85E-2	4.71E-2
79	2.83E-3	2.56E-3	2.22E-3	1.89E-3	1.70E-3	1.72E-3	79	2.22E-2	2.41E-2	2.70E-2	3.10E-2	3.72E-2	4.56E-2
80	2.74E-3	2.48E-3	2.15E-3	1.83E-3	1.65E-3	1.67E-3	80	2.15E-2	2.34E-2	2.60E-2	3.00E-2	3.59E-2	4.41E-2
81	2.65E-3	2.40E-3	2.08E-3	1.78E-3	1.61E-3	1.62E-3	81	2.08E-2	2.26E-2	2.49E-2	2.90E-2	3.46E-2	4.27E-2
82	2.57E-3	2.33E-3	2.02E-3	1.72E-3	1.56E-3	1.58E-3	82	2.01E-2	2.17E-2	2.40E-2	2.80E-2	3.35E-2	4.13E-2
83	2.49E-3	2.25E-3	1.96E-3	1.67E-3	1.51E-3	1.54E-3	83	1.94E-2	2.09E-2	2.31E-2	2.71E-2	3.23E-2	4.00E-2
84	2.41E-3	2.18E-3	1.90E-3	1.62E-3	1.47E-3	1.50E-3	84	1.87E-2	2.01E-2	2.23E-2	2.62E-2	3.12E-2	3.88E-2
85	2.33E-3	2.12E-3	1.84E-3	1.58E-3	1.43E-3	1.46E-3	85	1.80E-2	1.93E-2	2.15E-2	2.53E-2	3.02E-2	3.75E-2
86	2.26E-3	2.05E-3	1.78E-3	1.53E-3	1.39E-3	1.42E-3	86	1.73E-2	1.86E-2	2.08E-2	2.44E-2	2.92E-2	3.64E-2
87	2.19E-3	1.99E-3	1.73E-3	1.48E-3	1.35E-3	1.38E-3	87	1.68E-2	1.80E-2	2.02E-2	2.36E-2	2.83E-2	3.52E-2
88	2.12E-3	1.93E-3	1.68E-3	1.44E-3	1.31E-3	1.35E-3	88	1.62E-2	1.74E-2	1.95E-2	2.27E-2	2.74E-2	3.41E-2
89	2.06E-3	1.87E-3	1.63E-3	1.40E-3	1.27E-3	1.31E-3	89	1.57E-2	1.69E-2	1.89E-2	2.19E-2	2.65E-2	3.31E-2
90	2.00E-3	1.81E-3	1.58E-3	1.36E-3	1.24E-3	1.28E-3	90	1.52E-2	1.64E-2	1.83E-2	2.12E-2	2.57E-2	3.21E-2
91	1.94E-3	1.76E-3	1.53E-3	1.32E-3	1.20E-3	1.24E-3	91	1.47E-2	1.58E-2	1.77E-2	2.04E-2	2.49E-2	3.11E-2
92	1.88E-3	1.71E-3	1.49E-3	1.28E-3	1.17E-3	1.21E-3	92	1.42E-2	1.53E-2	1.71E-2	1.97E-2	2.41E-2	3.02E-2

TABLE VIII. Collision Strengths as a Function of Scattered Electron Energy E' for F-like ions

See page 11 for Explanation of Tables

$2p^* - 2s$						
Z	$E'=0.008$	$E'=0.04$	$E'=0.10$	$E'=0.21$	$E'=0.41$	$E'=0.75$
26	1.53E-1	1.67E-1	1.85E-1	2.10E-1	2.41E-1	2.75E-1
27	1.41E-1	1.55E-1	1.72E-1	1.95E-1	2.24E-1	2.55E-1
28	1.31E-1	1.44E-1	1.60E-1	1.82E-1	2.09E-1	2.38E-1
29	1.22E-1	1.34E-1	1.49E-1	1.70E-1	1.95E-1	2.22E-1
30	1.14E-1	1.25E-1	1.40E-1	1.59E-1	1.82E-1	2.08E-1
31	1.06E-1	1.17E-1	1.31E-1	1.49E-1	1.71E-1	1.95E-1
32	9.97E-2	1.10E-1	1.23E-1	1.40E-1	1.61E-1	1.83E-1
33	9.35E-2	1.03E-1	1.16E-1	1.31E-1	1.51E-1	1.72E-1
34	8.79E-2	9.69E-2	1.09E-1	1.24E-1	1.43E-1	1.63E-1
35	8.28E-2	9.13E-2	1.03E-1	1.17E-1	1.35E-1	1.54E-1
36	7.80E-2	8.62E-2	9.70E-2	1.10E-1	1.27E-1	1.45E-1
37	7.37E-2	8.14E-2	9.18E-2	1.05E-1	1.21E-1	1.38E-1
38	6.97E-2	7.71E-2	8.70E-2	9.92E-2	1.15E-1	1.31E-1
39	6.60E-2	7.31E-2	8.25E-2	9.42E-2	1.09E-1	1.24E-1
40	6.26E-2	6.93E-2	7.84E-2	8.95E-2	1.03E-1	1.18E-1
41	5.94E-2	6.59E-2	7.45E-2	8.52E-2	9.85E-2	1.13E-1
42	5.64E-2	6.12E-2	7.12E-2	8.17E-2	9.37E-2	1.07E-1
43	5.36E-2	5.83E-2	6.79E-2	7.79E-2	8.94E-2	1.02E-1
44	5.10E-2	5.56E-2	6.48E-2	7.44E-2	8.54E-2	9.80E-2
45	4.86E-2	5.31E-2	6.19E-2	7.10E-2	8.16E-2	9.38E-2
46	4.64E-2	5.07E-2	5.91E-2	6.79E-2	7.81E-2	8.98E-2
47	4.43E-2	4.85E-2	5.65E-2	6.50E-2	7.48E-2	8.61E-2
48	4.23E-2	4.64E-2	5.41E-2	6.22E-2	7.17E-2	8.26E-2
49	4.05E-2	4.44E-2	5.18E-2	5.96E-2	6.88E-2	7.94E-2
50	3.87E-2	4.25E-2	4.97E-2	5.72E-2	6.60E-2	7.63E-2
51	3.71E-2	4.08E-2	4.76E-2	5.49E-2	6.34E-2	7.33E-2
52	3.55E-2	3.91E-2	4.57E-2	5.27E-2	6.10E-2	7.06E-2
53	3.41E-2	3.76E-2	4.39E-2	5.07E-2	5.86E-2	6.80E-2
54	3.27E-2	3.61E-2	4.22E-2	4.87E-2	5.64E-2	6.55E-2
55	3.14E-2	3.47E-2	4.06E-2	4.69E-2	5.43E-2	6.31E-2
56	3.01E-2	3.34E-2	3.90E-2	4.51E-2	5.24E-2	6.09E-2
57	2.90E-2	3.21E-2	3.75E-2	4.34E-2	5.05E-2	5.88E-2
58	2.79E-2	3.09E-2	3.61E-2	4.18E-2	4.87E-2	5.68E-2
59	2.68E-2	2.98E-2	3.48E-2	4.03E-2	4.70E-2	5.49E-2
60	2.58E-2	2.87E-2	3.35E-2	3.89E-2	4.53E-2	5.30E-2
61	2.48E-2	2.76E-2	3.23E-2	3.75E-2	4.38E-2	5.13E-2
62	2.39E-2	2.67E-2	3.12E-2	3.62E-2	4.23E-2	4.96E-2
63	2.31E-2	2.57E-2	3.01E-2	3.50E-2	4.09E-2	4.80E-2
64	2.22E-2	2.48E-2	2.90E-2	3.38E-2	3.95E-2	4.65E-2
65	2.14E-2	2.39E-2	2.80E-2	3.26E-2	3.82E-2	4.50E-2
66	2.07E-2	2.31E-2	2.71E-2	3.15E-2	3.70E-2	4.36E-2
67	1.99E-2	2.23E-2	2.61E-2	3.05E-2	3.58E-2	4.23E-2
68	1.92E-2	2.16E-2	2.53E-2	2.95E-2	3.47E-2	4.10E-2
69	1.86E-2	2.09E-2	2.44E-2	2.85E-2	3.36E-2	3.98E-2
70	1.80E-2	2.02E-2	2.36E-2	2.76E-2	3.25E-2	3.86E-2
71	1.74E-2	1.95E-2	2.28E-2	2.67E-2	3.15E-2	3.74E-2
72	1.68E-2	1.89E-2	2.21E-2	2.59E-2	3.05E-2	3.64E-2
73	1.62E-2	1.82E-2	2.14E-2	2.50E-2	2.96E-2	3.53E-2
74	1.57E-2	1.77E-2	2.07E-2	2.43E-2	2.87E-2	3.43E-2
75	1.51E-2	1.78E-2	1.96E-2	2.32E-2	2.77E-2	3.33E-2
76	1.46E-2	1.72E-2	1.90E-2	2.25E-2	2.69E-2	3.24E-2
77	1.41E-2	1.66E-2	1.84E-2	2.18E-2	2.61E-2	3.14E-2
78	1.37E-2	1.61E-2	1.79E-2	2.11E-2	2.53E-2	3.06E-2
79	1.32E-2	1.56E-2	1.73E-2	2.04E-2	2.45E-2	2.97E-2
80	1.28E-2	1.51E-2	1.68E-2	1.98E-2	2.38E-2	2.89E-2
81	1.24E-2	1.46E-2	1.62E-2	1.92E-2	2.31E-2	2.81E-2
82	1.20E-2	1.42E-2	1.57E-2	1.86E-2	2.25E-2	2.73E-2
83	1.16E-2	1.37E-2	1.53E-2	1.81E-2	2.18E-2	2.66E-2
84	1.12E-2	1.33E-2	1.48E-2	1.75E-2	2.12E-2	2.59E-2
85	1.08E-2	1.29E-2	1.43E-2	1.70E-2	2.05E-2	2.51E-2
86	1.05E-2	1.25E-2	1.39E-2	1.65E-2	2.00E-2	2.45E-2
87	1.01E-2	1.21E-2	1.35E-2	1.60E-2	1.94E-2	2.38E-2
88	9.83E-3	1.17E-2	1.31E-2	1.55E-2	1.88E-2	2.32E-2
89	9.53E-3	1.14E-2	1.27E-2	1.51E-2	1.83E-2	2.26E-2
90	9.23E-3	1.10E-2	1.23E-2	1.46E-2	1.78E-2	2.20E-2
91	8.94E-3	1.07E-2	1.19E-2	1.42E-2	1.73E-2	2.14E-2
92	8.66E-3	1.03E-2	1.16E-2	1.38E-2	1.68E-2	2.08E-2

TABLE IX. Collision Strengths as a Function of Scattered Electron Energy E' for Na-like ions

See page 11 for Explanation of Tables

$3s - 3d^*$							$3s - 3d$						
Z	$E'=0.0025$	$E'=0.015$	$E'=0.04$	$E'=0.10$	$E'=0.21$	$E'=0.40$	Z	$E'=0.0025$	$E'=0.015$	$E'=0.04$	$E'=0.10$	$E'=0.21$	$E'=0.40$
26	1.21E-1	1.24E-1	1.28E-1	1.34E-1	1.39E-1	1.43E-1	26	1.81E-1	1.86E-1	1.93E-1	2.02E-1	2.09E-1	2.15E-1
27	1.09E-1	1.12E-1	1.15E-1	1.20E-1	1.25E-1	1.28E-1	27	1.64E-1	1.68E-1	1.73E-1	1.81E-1	1.88E-1	1.92E-1
28	9.89E-2	1.01E-1	1.04E-1	1.08E-1	1.12E-1	1.15E-1	28	1.48E-1	1.52E-1	1.57E-1	1.63E-1	1.69E-1	1.73E-1
29	9.01E-2	9.20E-2	9.47E-2	9.83E-2	1.02E-1	1.04E-1	29	1.35E-1	1.38E-1	1.42E-1	1.48E-1	1.53E-1	1.56E-1
30	8.24E-2	8.41E-2	8.64E-2	8.95E-2	9.22E-2	9.42E-2	30	1.24E-1	1.26E-1	1.30E-1	1.35E-1	1.39E-1	1.42E-1
31	7.56E-2	7.71E-2	7.92E-2	8.18E-2	8.41E-2	8.59E-2	31	1.13E-1	1.16E-1	1.19E-1	1.23E-1	1.27E-1	1.29E-1
32	6.97E-2	7.10E-2	7.28E-2	7.50E-2	7.71E-2	7.86E-2	32	1.04E-1	1.07E-1	1.09E-1	1.13E-1	1.16E-1	1.18E-1
33	6.44E-2	6.56E-2	6.71E-2	6.91E-2	7.08E-2	7.23E-2	33	9.66E-2	9.84E-2	1.01E-1	1.04E-1	1.07E-1	1.09E-1
34	5.97E-2	6.07E-2	6.21E-2	6.38E-2	6.54E-2	6.67E-2	34	8.96E-2	9.12E-2	9.33E-2	9.60E-2	9.85E-2	1.01E-1
35	5.55E-2	5.64E-2	5.76E-2	5.91E-2	6.05E-2	6.17E-2	35	8.33E-2	8.47E-2	8.66E-2	8.90E-2	9.12E-2	9.30E-2
36	5.17E-2	5.25E-2	5.36E-2	5.49E-2	5.61E-2	5.72E-2	36	7.76E-2	7.89E-2	8.06E-2	8.27E-2	8.47E-2	8.64E-2
37	4.83E-2	4.90E-2	5.00E-2	5.11E-2	5.22E-2	5.32E-2	37	7.25E-2	7.36E-2	7.52E-2	7.70E-2	7.88E-2	8.04E-2
38	4.52E-2	4.59E-2	4.67E-2	4.77E-2	4.87E-2	4.97E-2	38	6.78E-2	6.89E-2	7.03E-2	7.20E-2	7.36E-2	7.50E-2
39	4.24E-2	4.30E-2	4.37E-2	4.47E-2	4.56E-2	4.64E-2	39	6.36E-2	6.46E-2	6.58E-2	6.73E-2	6.88E-2	7.02E-2
40	3.98E-2	4.04E-2	4.10E-2	4.19E-2	4.27E-2	4.35E-2	40	5.98E-2	6.07E-2	6.18E-2	6.32E-2	6.46E-2	6.58E-2
41	3.75E-2	3.80E-2	3.86E-2	3.93E-2	4.01E-2	4.09E-2	41	5.63E-2	5.71E-2	5.81E-2	5.94E-2	6.07E-2	6.18E-2
42	3.53E-2	3.58E-2	3.63E-2	3.70E-2	3.77E-2	3.84E-2	42	5.31E-2	5.38E-2	5.48E-2	5.59E-2	5.71E-2	5.82E-2
43	3.34E-2	3.38E-2	3.43E-2	3.49E-2	3.56E-2	3.62E-2	43	5.01E-2	5.08E-2	5.17E-2	5.27E-2	5.39E-2	5.49E-2
44	3.16E-2	3.19E-2	3.24E-2	3.30E-2	3.36E-2	3.42E-2	44	4.74E-2	4.80E-2	4.88E-2	4.98E-2	5.09E-2	5.19E-2
45	2.99E-2	3.02E-2	3.07E-2	3.12E-2	3.18E-2	3.24E-2	45	4.49E-2	4.55E-2	4.62E-2	4.71E-2	4.81E-2	4.91E-2
46	2.83E-2	2.87E-2	2.90E-2	2.95E-2	3.01E-2	3.07E-2	46	4.26E-2	4.31E-2	4.38E-2	4.47E-2	4.56E-2	4.66E-2
47	2.69E-2	2.72E-2	2.76E-2	2.80E-2	2.85E-2	2.91E-2	47	4.04E-2	4.10E-2	4.16E-2	4.24E-2	4.33E-2	4.42E-2
48	2.56E-2	2.59E-2	2.62E-2	2.66E-2	2.71E-2	2.77E-2	48	3.84E-2	3.89E-2	3.95E-2	4.03E-2	4.11E-2	4.21E-2
49	2.43E-2	2.46E-2	2.49E-2	2.53E-2	2.58E-2	2.63E-2	49	3.66E-2	3.70E-2	3.76E-2	3.83E-2	3.91E-2	4.01E-2
50	2.32E-2	2.34E-2	2.37E-2	2.41E-2	2.45E-2	2.51E-2	50	3.48E-2	3.53E-2	3.58E-2	3.65E-2	3.73E-2	3.82E-2
51	2.21E-2	2.23E-2	2.26E-2	2.30E-2	2.34E-2	2.40E-2	51	3.32E-2	3.36E-2	3.42E-2	3.48E-2	3.56E-2	3.65E-2
52	2.11E-2	2.13E-2	2.16E-2	2.19E-2	2.23E-2	2.29E-2	52	3.17E-2	3.21E-2	3.26E-2	3.33E-2	3.40E-2	3.49E-2
53	2.02E-2	2.04E-2	2.06E-2	2.09E-2	2.13E-2	2.19E-2	53	3.03E-2	3.07E-2	3.12E-2	3.18E-2	3.25E-2	3.33E-2
54	1.93E-2	1.95E-2	1.97E-2	2.00E-2	2.04E-2	2.09E-2	54	2.90E-2	2.94E-2	2.98E-2	3.04E-2	3.11E-2	3.19E-2
55	1.85E-2	1.86E-2	1.89E-2	1.92E-2	1.95E-2	2.00E-2	55	2.78E-2	2.81E-2	2.85E-2	2.91E-2	2.98E-2	3.06E-2
56	1.77E-2	1.79E-2	1.81E-2	1.83E-2	1.87E-2	1.92E-2	56	2.66E-2	2.69E-2	2.73E-2	2.79E-2	2.86E-2	2.94E-2
57	1.69E-2	1.71E-2	1.73E-2	1.76E-2	1.80E-2	1.85E-2	57	2.55E-2	2.58E-2	2.62E-2	2.68E-2	2.74E-2	2.82E-2
58	1.63E-2	1.64E-2	1.66E-2	1.69E-2	1.72E-2	1.77E-2	58	2.44E-2	2.48E-2	2.52E-2	2.57E-2	2.63E-2	2.71E-2
59	1.56E-2	1.58E-2	1.59E-2	1.62E-2	1.65E-2	1.70E-2	59	2.35E-2	2.38E-2	2.42E-2	2.47E-2	2.53E-2	2.61E-2
60	1.50E-2	1.51E-2	1.53E-2	1.56E-2	1.59E-2	1.64E-2	60	2.25E-2	2.28E-2	2.32E-2	2.37E-2	2.44E-2	2.51E-2
61	1.44E-2	1.46E-2	1.47E-2	1.50E-2	1.53E-2	1.58E-2	61	2.17E-2	2.20E-2	2.23E-2	2.28E-2	2.34E-2	2.43E-2
62	1.38E-2	1.40E-2	1.42E-2	1.44E-2	1.47E-2	1.52E-2	62	2.08E-2	2.11E-2	2.15E-2	2.20E-2	2.26E-2	2.34E-2
63	1.33E-2	1.35E-2	1.36E-2	1.39E-2	1.42E-2	1.47E-2	63	2.01E-2	2.03E-2	2.07E-2	2.12E-2	2.18E-2	2.26E-2
64	1.28E-2	1.30E-2	1.31E-2	1.34E-2	1.37E-2	1.42E-2	64	1.93E-2	1.96E-2	1.99E-2	2.04E-2	2.10E-2	2.18E-2
65	1.24E-2	1.25E-2	1.26E-2	1.29E-2	1.32E-2	1.37E-2	65	1.86E-2	1.89E-2	1.92E-2	1.97E-2	2.03E-2	2.11E-2
66	1.19E-2	1.20E-2	1.22E-2	1.24E-2	1.28E-2	1.32E-2	66	1.79E-2	1.82E-2	1.85E-2	1.90E-2	1.96E-2	2.04E-2
67	1.15E-2	1.16E-2	1.18E-2	1.20E-2	1.23E-2	1.28E-2	67	1.73E-2	1.75E-2	1.79E-2	1.84E-2	1.90E-2	1.98E-2
68	1.11E-2	1.12E-2	1.14E-2	1.16E-2	1.19E-2	1.24E-2	68	1.67E-2	1.69E-2	1.73E-2	1.77E-2	1.84E-2	1.91E-2
69	1.07E-2	1.08E-2	1.10E-2	1.12E-2	1.15E-2	1.20E-2	69	1.61E-2	1.63E-2	1.67E-2	1.72E-2	1.78E-2	1.86E-2
70	1.03E-2	1.05E-2	1.06E-2	1.08E-2	1.12E-2	1.16E-2	70	1.56E-2	1.58E-2	1.61E-2	1.66E-2	1.72E-2	1.80E-2
71	9.99E-3	1.01E-2	1.03E-2	1.05E-2	1.08E-2	1.13E-2	71	1.50E-2	1.53E-2	1.56E-2	1.61E-2	1.67E-2	1.75E-2
72	9.66E-3	9.77E-3	9.92E-3	1.01E-2	1.05E-2	1.09E-2	72	1.45E-2	1.48E-2	1.51E-2	1.56E-2	1.62E-2	1.69E-2
73	9.34E-3	9.45E-3	9.59E-3	9.82E-3	1.01E-2	1.06E-2	73	1.40E-2	1.43E-2	1.46E-2	1.51E-2	1.57E-2	1.65E-2
74	9.04E-3	9.14E-3	9.29E-3	9.51E-3	9.83E-3	1.03E-2	74	1.36E-2	1.38E-2	1.41E-2	1.46E-2	1.52E-2	1.60E-2
75	8.74E-3	8.85E-3	8.99E-3	9.22E-3	9.54E-3	1.00E-2	75	1.32E-2	1.34E-2	1.37E-2	1.42E-2	1.48E-2	1.55E-2
76	8.46E-3	8.57E-3	8.71E-3	8.94E-3	9.26E-3	9.74E-3	76	1.27E-2	1.29E-2	1.33E-2	1.37E-2	1.43E-2	1.51E-2
77	8.19E-3	8.30E-3	8.44E-3	8.66E-3	8.99E-3	9.47E-3	77	1.23E-2	1.25E-2	1.29E-2	1.33E-2	1.39E-2	1.47E-2
78	7.94E-3	8.04E-3	8.18E-3	8.41E-3	8.73E-3	9.21E-3	78	1.19E-2	1.21E-2	1.25E-2	1.29E-2	1.35E-2	1.43E-2
79	7.69E-3	7.79E-3	7.93E-3	8.16E-3	8.48E-3	8.96E-3	79	1.16E-2	1.18E-2	1.21E-2	1.26E-2	1.32E-2	1.40E-2
80	7.45E-3	7.55E-3	7.69E-3	7.92E-3	8.25E-3	8.73E-3	80	1.12E-2	1.14E-2	1.17E-2	1.22E-2	1.28E-2	1.36E-2
81	7.23E-3	7.32E-3	7.47E-3	7.69E-3	8.02E-3	8.50E-3	81	1.09E-2	1.11E-2	1.14E-2	1.19E-2	1.25E-2	1.33E-2
82	7.01E-3	7.11E-3	7.24E-3	7.47E-3	7.80E-3	8.28E-3	82	1.05E-2	1.07E-2	1.11E-2	1.15E-2	1.21E-2	1.29E-2
83	6.80E-3	6.90E-3	7.03E-3	7.26E-3	7.59E-3	8.07E-3	83	1.02E-2	1.04E-2	1.07E-2	1.12E-2	1.18E-2	1.26E-2
84	6.60E-3	6.69E-3	6.83E-3	7.06E-3	7.39E-3	7.87E-3	84	9.91E-3	1.01E-2	1.04E-2	1.09E-2	1.15E-2	1.23E-2
85	6.41E-3	6.50E-3	6.63E-3	6.86E-3	7.19E-3	7.67E-3	85	9.62E-3	9.82E-3	1.01E-2	1.06E-2	1.12E-2	1.20E-2
86	6.22E-3	6.31E-3	6.45E-3	6.68E-3	7.00E-3	7.49E-3	86	9.33E-3	9.53E-3	9.84E-3	1.03E-2	1.09E-2	1.17E-2
87	6.04E-3	6.13E-3	6.26E-3	6.49E-3	6.83E-3	7.30E-3	87	9.06E-3	9.26E-3	9.56E-3	1.00E-2	1.06E-2	1.15E-2
88	5.86E-3	5.95E-3	6.09E-3	6.32E-3	6.65E-3	7.13E-3	88	8.80E-3	8.99E-3	9.29E-3	9.78E-3	1.04E-2	1.12E-2
89	5.70E-3	5.79E-3	5.92E-3	6.15E-3	6.48E-3	6.96E-3	89	8.54E-3	8.74E-3	9.03E-3	9.52E-3	1.01E-2	1.09E-2
90	5.53E-3	5.62E-3	5.76E-3	5.99E-3	6.32E-3	6.80E-3	90	8.30E-3	8.49E-3	8.79E-3	9.27E-3	9.89E-3	1.07E-2
91	5.38E-3	5.47E-3	5.60E-3	5.83E-3	6.16E-3	6.64E-3	91	8.06E-3	8.25E-3	8.55E-3	9.03E-3	9.65E-3	1.05E-2
92	5.23E-3	5.31E-3	5.45E-3	5.68E-3	6.01E-3	6.49E-3	92	7.83E-3	8.02E-3	8.31E-3	8.80E-3	9.42E-3	1.02E-2

TABLE IX. Collision Strengths as a Function of Scattered Electron Energy E' for Na-like ions

See page 11 for Explanation of Tables

$3s - 3p^*$							$3s - 3p$						
Z	$E'=0.0025$	$E'=0.015$	$E'=0.04$	$E'=0.10$	$E'=0.21$	$E'=0.40$	Z	$E'=0.0025$	$E'=0.015$	$E'=0.04$	$E'=0.10$	$E'=0.21$	$E'=0.40$
26	1.23E+0	1.27E+0	1.45E+0	1.68E+0	1.93E+0	2.19E+0	26	2.41E+0	2.53E+0	2.81E+0	3.30E+0	3.79E+0	4.31E+0
27	1.12E+0	1.16E+0	1.32E+0	1.53E+0	1.76E+0	2.01E+0	27	2.18E+0	2.31E+0	2.56E+0	3.01E+0	3.45E+0	3.93E+0
28	1.03E+0	1.06E+0	1.22E+0	1.41E+0	1.61E+0	1.84E+0	28	1.99E+0	2.12E+0	2.35E+0	2.75E+0	3.16E+0	3.60E+0
29	9.44E-1	9.80E-1	1.12E+0	1.29E+0	1.49E+0	1.70E+0	29	1.82E+0	1.96E+0	2.15E+0	2.53E+0	2.91E+0	3.31E+0
30	8.70E-1	9.05E-1	1.03E+0	1.19E+0	1.38E+0	1.57E+0	30	1.68E+0	1.81E+0	1.98E+0	2.33E+0	2.68E+0	3.06E+0
31	8.05E-1	8.39E-1	9.57E-1	1.10E+0	1.27E+0	1.46E+0	31	1.54E+0	1.67E+0	1.83E+0	2.14E+0	2.48E+0	2.83E+0
32	7.47E-1	7.80E-1	8.90E-1	1.02E+0	1.19E+0	1.36E+0	32	1.43E+0	1.55E+0	1.69E+0	1.99E+0	2.30E+0	2.62E+0
33	6.95E-1	7.26E-1	8.29E-1	9.55E-1	1.11E+0	1.27E+0	33	1.32E+0	1.45E+0	1.57E+0	1.84E+0	2.13E+0	2.44E+0
34	6.48E-1	6.78E-1	7.75E-1	8.92E-1	1.04E+0	1.19E+0	34	1.23E+0	1.35E+0	1.46E+0	1.72E+0	1.99E+0	2.28E+0
35	6.05E-1	6.35E-1	7.25E-1	8.36E-1	9.72E-1	1.11E+0	35	1.14E+0	1.26E+0	1.36E+0	1.60E+0	1.86E+0	2.13E+0
36	5.67E-1	5.95E-1	6.80E-1	7.85E-1	9.13E-1	1.04E+0	36	1.07E+0	1.18E+0	1.27E+0	1.50E+0	1.74E+0	1.99E+0
37	5.32E-1	5.60E-1	6.39E-1	7.38E-1	8.60E-1	9.84E-1	37	9.99E-1	1.11E+0	1.19E+0	1.41E+0	1.63E+0	1.87E+0
38	5.00E-1	5.27E-1	6.02E-1	6.95E-1	8.11E-1	9.28E-1	38	9.39E-1	1.04E+0	1.12E+0	1.32E+0	1.53E+0	1.76E+0
39	4.71E-1	4.97E-1	5.68E-1	6.56E-1	7.66E-1	8.77E-1	39	8.83E-1	9.78E-1	1.05E+0	1.24E+0	1.44E+0	1.65E+0
40	4.44E-1	4.69E-1	5.36E-1	6.21E-1	7.25E-1	8.31E-1	40	8.34E-1	9.20E-1	9.88E-1	1.17E+0	1.36E+0	1.56E+0
41	4.19E-1	4.44E-1	5.07E-1	5.88E-1	6.87E-1	7.88E-1	41	7.88E-1	8.66E-1	9.31E-1	1.10E+0	1.28E+0	1.47E+0
42	3.97E-1	4.21E-1	4.81E-1	5.57E-1	6.52E-1	7.48E-1	42	7.45E-1	8.16E-1	8.78E-1	1.04E+0	1.21E+0	1.39E+0
43	3.76E-1	3.99E-1	4.56E-1	5.29E-1	6.20E-1	7.11E-1	43	7.07E-1	7.68E-1	8.30E-1	9.79E-1	1.14E+0	1.31E+0
44	3.56E-1	3.79E-1	4.33E-1	5.03E-1	5.90E-1	6.77E-1	44	6.69E-1	7.25E-1	7.85E-1	9.26E-1	1.08E+0	1.24E+0
45	3.39E-1	3.61E-1	4.12E-1	4.79E-1	5.62E-1	6.45E-1	45	6.34E-1	6.83E-1	7.44E-1	8.76E-1	1.03E+0	1.18E+0
46	3.22E-1	3.43E-1	3.92E-1	4.57E-1	5.36E-1	6.16E-1	46	6.02E-1	6.45E-1	7.06E-1	8.30E-1	9.74E-1	1.12E+0
47	3.06E-1	3.27E-1	3.74E-1	4.36E-1	5.12E-1	5.88E-1	47	5.69E-1	6.10E-1	6.71E-1	7.87E-1	9.24E-1	1.06E+0
48	2.92E-1	3.12E-1	3.56E-1	4.16E-1	4.89E-1	5.62E-1	48	5.39E-1	5.76E-1	6.38E-1	7.40E-1	8.78E-1	1.01E+0
49	2.79E-1	2.98E-1	3.40E-1	3.98E-1	4.68E-1	5.38E-1	49	5.11E-1	5.46E-1	6.07E-1	7.10E-1	8.35E-1	9.63E-1
50	2.66E-1	2.85E-1	3.25E-1	3.81E-1	4.48E-1	5.16E-1	50	4.84E-1	5.17E-1	5.79E-1	6.74E-1	7.95E-1	9.17E-1
51	2.54E-1	2.73E-1	3.11E-1	3.65E-1	4.29E-1	4.94E-1	51	4.59E-1	4.92E-1	5.52E-1	6.42E-1	7.57E-1	8.74E-1
52	2.43E-1	2.61E-1	2.98E-1	3.50E-1	4.12E-1	4.74E-1	52	4.37E-1	4.68E-1	5.27E-1	6.11E-1	7.21E-1	8.34E-1
53	2.33E-1	2.50E-1	2.85E-1	3.35E-1	3.95E-1	4.56E-1	53	4.17E-1	4.47E-1	5.04E-1	5.82E-1	6.88E-1	7.96E-1
54	2.23E-1	2.40E-1	2.74E-1	3.22E-1	3.80E-1	4.38E-1	54	3.99E-1	4.27E-1	4.81E-1	5.54E-1	6.56E-1	7.60E-1
55	2.13E-1	2.30E-1	2.63E-1	3.09E-1	3.65E-1	4.21E-1	55	3.82E-1	4.09E-1	4.60E-1	5.29E-1	6.27E-1	7.27E-1
56	2.05E-1	2.21E-1	2.52E-1	2.97E-1	3.51E-1	4.05E-1	56	3.66E-1	3.93E-1	4.40E-1	5.05E-1	5.99E-1	6.95E-1
57	1.97E-1	2.12E-1	2.42E-1	2.86E-1	3.38E-1	3.90E-1	57	3.50E-1	3.77E-1	4.20E-1	4.82E-1	5.72E-1	6.65E-1
58	1.89E-1	2.04E-1	2.33E-1	2.75E-1	3.26E-1	3.76E-1	58	3.35E-1	3.62E-1	4.01E-1	4.61E-1	5.47E-1	6.36E-1
59	1.80E-1	2.09E-1	2.18E-1	2.61E-1	3.13E-1	3.63E-1	59	3.25E-1	3.34E-1	3.85E-1	4.45E-1	5.20E-1	6.07E-1
60	1.73E-1	2.01E-1	2.10E-1	2.52E-1	3.02E-1	3.50E-1	60	3.10E-1	3.21E-1	3.67E-1	4.26E-1	4.98E-1	5.82E-1
61	1.67E-1	1.93E-1	2.02E-1	2.43E-1	2.91E-1	3.38E-1	61	2.96E-1	3.09E-1	3.50E-1	4.08E-1	4.78E-1	5.58E-1
62	1.60E-1	1.86E-1	1.95E-1	2.34E-1	2.81E-1	3.26E-1	62	2.83E-1	2.98E-1	3.34E-1	3.92E-1	4.58E-1	5.35E-1
63	1.54E-1	1.79E-1	1.88E-1	2.26E-1	2.71E-1	3.15E-1	63	2.70E-1	2.88E-1	3.19E-1	3.75E-1	4.39E-1	5.14E-1
64	1.49E-1	1.73E-1	1.81E-1	2.18E-1	2.62E-1	3.05E-1	64	2.58E-1	2.79E-1	3.05E-1	3.60E-1	4.22E-1	4.93E-1
65	1.43E-1	1.67E-1	1.75E-1	2.11E-1	2.53E-1	2.95E-1	65	2.46E-1	2.69E-1	2.91E-1	3.45E-1	4.05E-1	4.74E-1
66	1.38E-1	1.61E-1	1.69E-1	2.04E-1	2.45E-1	2.85E-1	66	2.35E-1	2.59E-1	2.79E-1	3.32E-1	3.89E-1	4.56E-1
67	1.33E-1	1.55E-1	1.63E-1	1.97E-1	2.37E-1	2.76E-1	67	2.25E-1	2.50E-1	2.67E-1	3.18E-1	3.74E-1	4.38E-1
68	1.28E-1	1.50E-1	1.58E-1	1.91E-1	2.29E-1	2.67E-1	68	2.16E-1	2.40E-1	2.56E-1	3.05E-1	3.59E-1	4.21E-1
69	1.24E-1	1.45E-1	1.52E-1	1.85E-1	2.22E-1	2.59E-1	69	2.09E-1	2.31E-1	2.46E-1	2.93E-1	3.45E-1	4.05E-1
70	1.20E-1	1.40E-1	1.47E-1	1.79E-1	2.15E-1	2.51E-1	70	2.02E-1	2.21E-1	2.36E-1	2.81E-1	3.32E-1	3.90E-1
71	1.16E-1	1.35E-1	1.43E-1	1.73E-1	2.08E-1	2.43E-1	71	1.95E-1	2.11E-1	2.28E-1	2.70E-1	3.20E-1	3.76E-1
72	1.12E-1	1.31E-1	1.38E-1	1.68E-1	2.02E-1	2.36E-1	72	1.88E-1	2.02E-1	2.19E-1	2.59E-1	3.07E-1	3.62E-1
73	1.08E-1	1.26E-1	1.34E-1	1.62E-1	1.95E-1	2.29E-1	73	1.82E-1	1.93E-1	2.11E-1	2.49E-1	2.96E-1	3.49E-1
74	1.05E-1	1.22E-1	1.29E-1	1.57E-1	1.89E-1	2.22E-1	74	1.75E-1	1.84E-1	2.04E-1	2.39E-1	2.85E-1	3.36E-1
75	1.01E-1	1.18E-1	1.25E-1	1.52E-1	1.84E-1	2.15E-1	75	1.69E-1	1.76E-1	1.97E-1	2.30E-1	2.74E-1	3.24E-1
76	9.77E-2	1.15E-1	1.21E-1	1.48E-1	1.78E-1	2.09E-1	76	1.62E-1	1.69E-1	1.91E-1	2.21E-1	2.64E-1	3.13E-1
77	9.46E-2	1.11E-1	1.18E-1	1.43E-1	1.73E-1	2.03E-1	77	1.55E-1	1.63E-1	1.84E-1	2.12E-1	2.54E-1	3.01E-1
78	9.16E-2	1.07E-1	1.14E-1	1.39E-1	1.68E-1	1.97E-1	78	1.48E-1	1.57E-1	1.78E-1	2.04E-1	2.45E-1	2.91E-1
79	8.88E-2	1.04E-1	1.11E-1	1.35E-1	1.63E-1	1.92E-1	79	1.43E-1	1.52E-1	1.72E-1	1.97E-1	2.36E-1	2.81E-1
80	8.60E-2	1.01E-1	1.07E-1	1.31E-1	1.58E-1	1.86E-1	80	1.38E-1	1.47E-1	1.65E-1	1.89E-1	2.27E-1	2.71E-1
81	8.33E-2	9.78E-2	1.04E-1	1.27E-1	1.53E-1	1.81E-1	81	1.33E-1	1.43E-1	1.59E-1	1.82E-1	2.19E-1	2.62E-1
82	8.07E-2	9.48E-2	1.01E-1	1.23E-1	1.49E-1	1.76E-1	82	1.28E-1	1.38E-1	1.53E-1	1.75E-1	2.11E-1	2.53E-1
83	7.83E-2	9.19E-2	9.81E-2	1.20E-1	1.45E-1	1.71E-1	83	1.24E-1	1.33E-1	1.47E-1	1.69E-1	2.03E-1	2.44E-1
84	7.59E-2	8.91E-2	9.52E-2	1.16E-1	1.41E-1	1.67E-1	84	1.20E-1	1.29E-1	1.41E-1	1.63E-1	1.96E-1	2.35E-1
85	7.35E-2	8.64E-2	9.24E-2	1.13E-1	1.37E-1	1.62E-1	85	1.16E-1	1.23E-1	1.35E-1	1.58E-1	1.89E-1	2.28E-1
86	7.14E-2	8.39E-2	8.97E-2	1.10E-1	1.33E-1	1.58E-1	86	1.12E-1	1.18E-1	1.30E-1	1.52E-1	1.82E-1	2.20E-1
87	6.93E-2	8.14E-2	8.71E-2	1.07E-1	1.29E-1	1.53E-1	87	1.07E-1	1.14E-1	1.25E-1	1.47E-1	1.76E-1	2.12E-1
88	6.72E-2	7.90E-2	8.46E-2	1.04E-1	1.26E-1	1.49E-1	88	1.03E-1	1.09E-1	1.20E-1	1.42E-1	1.69E-1	2.05E-1
89	6.52E-2	7.67E-2	8.22E-2	1.01E-1	1.22E-1	1.45E-1	89	9.94E-2	1.05E-1	1.16E-1	1.37E-1	1.63E-1	1.98E-1
90	6.33E-2	7.44E-2	7.99E-2	9.78E-2	1.19E-1	1.42E-1	90	9.59E-2	1.02E-1	1.12E-1	1.32E-1	1.58E-1	1.92E-1
91	6.14E-2	7.22E-2	7.76E-2	9.51E-2	1.16E-1	1.38E-1	91	9.25E-2	9.82E-2	1.08E-1	1.28E-1	1.52E-1	1.85E-1
92	5.96E-2	7.01E-2	7.54E-2	9.24E-2	1.12E-1	1.34E-1	92	8.95E-2	9.51E-2	1.05E-1	1.23E-1	1.47E-1	1.79E-1

TABLE IX. Collision Strengths as a Function of Scattered Electron Energy E' for Na-Like ions

See page 11 for Explanation of Tables

$3d^* - 3d$							$3p^* - 3d^*$						
Z	$E'=0.0025$	$E'=0.015$	$E'=0.04$	$E'=0.10$	$E'=0.21$	$E'=0.40$	Z	$E'=0.0025$	$E'=0.015$	$E'=0.04$	$E'=0.10$	$E'=0.21$	$E'=0.40$
26	2.44E-1	2.04E-1	1.56E-1	1.10E-1	8.82E-2	8.16E-2	26	1.74E+0	1.89E+0	2.03E+0	2.41E+0	2.80E+0	3.19E+0
27	2.15E-1	1.80E-1	1.38E-1	9.74E-2	7.86E-2	7.28E-2	27	1.58E+0	1.71E+0	1.84E+0	2.18E+0	2.53E+0	2.88E+0
28	1.91E-1	1.60E-1	1.23E-1	8.73E-2	7.05E-2	6.53E-2	28	1.44E+0	1.55E+0	1.67E+0	1.98E+0	2.30E+0	2.62E+0
29	1.71E-1	1.43E-1	1.11E-1	7.86E-2	6.36E-2	5.89E-2	29	1.31E+0	1.41E+0	1.53E+0	1.80E+0	2.10E+0	2.39E+0
30	1.53E-1	1.29E-1	9.99E-2	7.12E-2	5.77E-2	5.35E-2	30	1.21E+0	1.29E+0	1.40E+0	1.65E+0	1.92E+0	2.19E+0
31	1.39E-1	1.17E-1	9.07E-2	6.49E-2	5.26E-2	4.88E-2	31	1.11E+0	1.19E+0	1.29E+0	1.52E+0	1.76E+0	2.02E+0
32	1.26E-1	1.06E-1	8.27E-2	5.93E-2	4.81E-2	4.47E-2	32	1.03E+0	1.10E+0	1.19E+0	1.40E+0	1.63E+0	1.86E+0
33	1.15E-1	9.72E-2	7.57E-2	5.44E-2	4.42E-2	4.11E-2	33	9.52E-1	1.01E+0	1.11E+0	1.29E+0	1.51E+0	1.72E+0
34	1.05E-1	8.91E-2	6.96E-2	5.01E-2	4.08E-2	3.79E-2	34	8.85E-1	9.38E-1	1.03E+0	1.20E+0	1.40E+0	1.60E+0
35	9.68E-2	8.21E-2	6.42E-2	4.63E-2	3.77E-2	3.51E-2	35	8.23E-1	8.71E-1	9.57E-1	1.12E+0	1.30E+0	1.49E+0
36	8.93E-2	7.58E-2	5.94E-2	4.29E-2	3.50E-2	3.26E-2	36	7.68E-1	8.11E-1	8.93E-1	1.04E+0	1.22E+0	1.39E+0
37	8.26E-2	7.02E-2	5.51E-2	3.99E-2	3.26E-2	3.03E-2	37	7.17E-1	7.56E-1	8.36E-1	9.73E-1	1.14E+0	1.30E+0
38	7.67E-2	6.53E-2	5.12E-2	3.72E-2	3.04E-2	2.83E-2	38	6.70E-1	7.07E-1	7.83E-1	9.11E-1	1.06E+0	1.22E+0
39	7.14E-2	6.08E-2	4.78E-2	3.48E-2	2.84E-2	2.65E-2	39	6.28E-1	6.62E-1	7.36E-1	8.55E-1	1.00E+0	1.15E+0
40	6.66E-2	5.68E-2	4.47E-2	3.26E-2	2.67E-2	2.48E-2	40	5.88E-1	6.21E-1	6.92E-1	8.03E-1	9.40E-1	1.08E+0
41	6.23E-2	5.31E-2	4.19E-2	3.05E-2	2.50E-2	2.33E-2	41	5.52E-1	5.84E-1	6.53E-1	7.55E-1	8.86E-1	1.02E+0
42	5.84E-2	4.98E-2	3.93E-2	2.87E-2	2.36E-2	2.20E-2	42	5.19E-1	5.49E-1	6.16E-1	7.12E-1	8.35E-1	9.59E-1
43	5.48E-2	4.68E-2	3.70E-2	2.71E-2	2.22E-2	2.07E-2	43	4.89E-1	5.19E-1	5.82E-1	6.72E-1	7.89E-1	9.06E-1
44	5.16E-2	4.41E-2	3.49E-2	2.55E-2	2.10E-2	1.96E-2	44	4.61E-1	4.90E-1	5.51E-1	6.35E-1	7.46E-1	8.58E-1
45	4.86E-2	4.16E-2	3.29E-2	2.41E-2	1.98E-2	1.86E-2	45	4.36E-1	4.64E-1	5.22E-1	6.01E-1	7.07E-1	8.13E-1
46	4.59E-2	3.93E-2	3.11E-2	2.28E-2	1.88E-2	1.76E-2	46	4.12E-1	4.40E-1	4.95E-1	5.69E-1	6.70E-1	7.71E-1
47	4.34E-2	3.72E-2	2.95E-2	2.17E-2	1.79E-2	1.67E-2	47	3.91E-1	4.18E-1	4.70E-1	5.39E-1	6.36E-1	7.32E-1
48	4.11E-2	3.52E-2	2.80E-2	2.06E-2	1.70E-2	1.59E-2	48	3.72E-1	3.97E-1	4.47E-1	5.12E-1	6.04E-1	6.96E-1
49	3.90E-2	3.34E-2	2.66E-2	1.96E-2	1.61E-2	1.51E-2	49	3.54E-1	3.79E-1	4.25E-1	4.86E-1	5.74E-1	6.63E-1
50	3.70E-2	3.18E-2	2.53E-2	1.86E-2	1.54E-2	1.44E-2	50	3.38E-1	3.61E-1	4.05E-1	4.63E-1	5.46E-1	6.31E-1
51	3.52E-2	3.02E-2	2.40E-2	1.77E-2	1.46E-2	1.38E-2	51	3.22E-1	3.45E-1	3.85E-1	4.40E-1	5.20E-1	6.02E-1
52	3.35E-2	2.88E-2	2.29E-2	1.69E-2	1.40E-2	1.32E-2	52	3.07E-1	3.30E-1	3.67E-1	4.19E-1	4.96E-1	5.74E-1
53	3.19E-2	2.75E-2	2.19E-2	1.62E-2	1.34E-2	1.26E-2	53	2.93E-1	3.16E-1	3.50E-1	4.00E-1	4.73E-1	5.48E-1
54	3.05E-2	2.62E-2	2.09E-2	1.55E-2	1.28E-2	1.21E-2	54	2.80E-1	3.02E-1	3.33E-1	3.82E-1	4.52E-1	5.24E-1
55	2.91E-2	2.50E-2	2.00E-2	1.48E-2	1.23E-2	1.16E-2	55	2.67E-1	2.88E-1	3.18E-1	3.65E-1	4.31E-1	5.01E-1
56	2.78E-2	2.40E-2	1.91E-2	1.42E-2	1.18E-2	1.11E-2	56	2.55E-1	2.75E-1	3.03E-1	3.48E-1	4.12E-1	4.79E-1
57	2.66E-2	2.30E-2	1.83E-2	1.36E-2	1.13E-2	1.06E-2	57	2.43E-1	2.63E-1	2.89E-1	3.33E-1	3.95E-1	4.59E-1
58	2.55E-2	2.20E-2	1.76E-2	1.31E-2	1.08E-2	1.02E-2	58	2.32E-1	2.51E-1	2.76E-1	3.19E-1	3.78E-1	4.40E-1
59	2.45E-2	2.11E-2	1.69E-2	1.25E-2	1.04E-2	9.85E-3	59	2.25E-1	2.37E-1	2.64E-1	3.09E-1	3.60E-1	4.20E-1
60	2.35E-2	2.03E-2	1.62E-2	1.20E-2	1.00E-2	9.48E-3	60	2.15E-1	2.29E-1	2.52E-1	2.96E-1	3.46E-1	4.03E-1
61	2.26E-2	1.95E-2	1.56E-2	1.16E-2	9.64E-3	9.14E-3	61	2.05E-1	2.21E-1	2.41E-1	2.84E-1	3.32E-1	3.87E-1
62	2.17E-2	1.87E-2	1.50E-2	1.12E-2	9.28E-3	8.81E-3	62	1.95E-1	2.13E-1	2.30E-1	2.73E-1	3.18E-1	3.71E-1
63	2.09E-2	1.80E-2	1.44E-2	1.07E-2	8.95E-3	8.50E-3	63	1.87E-1	2.05E-1	2.20E-1	2.62E-1	3.06E-1	3.57E-1
64	2.01E-2	1.73E-2	1.39E-2	1.04E-2	8.64E-3	8.21E-3	64	1.79E-1	1.98E-1	2.11E-1	2.51E-1	2.94E-1	3.43E-1
65	1.93E-2	1.67E-2	1.34E-2	1.00E-2	8.34E-3	7.94E-3	65	1.72E-1	1.90E-1	2.03E-1	2.41E-1	2.82E-1	3.30E-1
66	1.86E-2	1.61E-2	1.29E-2	9.65E-3	8.05E-3	7.67E-3	66	1.65E-1	1.83E-1	1.94E-1	2.31E-1	2.72E-1	3.18E-1
67	1.80E-2	1.55E-2	1.25E-2	9.32E-3	7.78E-3	7.43E-3	67	1.59E-1	1.75E-1	1.87E-1	2.22E-1	2.61E-1	3.06E-1
68	1.74E-2	1.50E-2	1.21E-2	9.01E-3	7.53E-3	7.19E-3	68	1.54E-1	1.68E-1	1.80E-1	2.13E-1	2.51E-1	2.95E-1
69	1.68E-2	1.45E-2	1.17E-2	8.71E-3	7.28E-3	6.96E-3	69	1.49E-1	1.61E-1	1.73E-1	2.05E-1	2.42E-1	2.84E-1
70	1.62E-2	1.40E-2	1.13E-2	8.43E-3	7.05E-3	6.75E-3	70	1.44E-1	1.54E-1	1.67E-1	1.97E-1	2.33E-1	2.74E-1
71	1.57E-2	1.36E-2	1.09E-2	8.16E-3	6.83E-3	6.55E-3	71	1.39E-1	1.47E-1	1.61E-1	1.90E-1	2.25E-1	2.64E-1
72	1.51E-2	1.31E-2	1.06E-2	7.91E-3	6.62E-3	6.35E-3	72	1.34E-1	1.41E-1	1.56E-1	1.82E-1	2.16E-1	2.55E-1
73	1.46E-2	1.27E-2	1.02E-2	7.66E-3	6.42E-3	6.17E-3	73	1.29E-1	1.35E-1	1.51E-1	1.75E-1	2.09E-1	2.46E-1
74	1.42E-2	1.23E-2	9.91E-3	7.43E-3	6.23E-3	5.99E-3	74	1.24E-1	1.30E-1	1.46E-1	1.69E-1	2.01E-1	2.37E-1
75	1.37E-2	1.19E-2	9.61E-3	7.21E-3	6.05E-3	5.82E-3	75	1.20E-1	1.25E-1	1.41E-1	1.63E-1	1.94E-1	2.29E-1
76	1.33E-2	1.16E-2	9.32E-3	6.99E-3	5.87E-3	5.66E-3	76	1.15E-1	1.21E-1	1.36E-1	1.57E-1	1.87E-1	2.21E-1
77	1.29E-2	1.12E-2	9.04E-3	6.79E-3	5.71E-3	5.51E-3	77	1.10E-1	1.17E-1	1.32E-1	1.51E-1	1.80E-1	2.14E-1
78	1.25E-2	1.09E-2	8.78E-3	6.60E-3	5.55E-3	5.36E-3	78	1.06E-1	1.13E-1	1.27E-1	1.45E-1	1.74E-1	2.07E-1
79	1.22E-2	1.06E-2	8.53E-3	6.41E-3	5.39E-3	5.22E-3	79	1.03E-1	1.10E-1	1.23E-1	1.40E-1	1.68E-1	2.00E-1
80	1.18E-2	1.03E-2	8.29E-3	6.23E-3	5.25E-3	5.08E-3	80	9.93E-2	1.06E-1	1.18E-1	1.35E-1	1.62E-1	1.93E-1
81	1.15E-2	9.97E-3	8.05E-3	6.06E-3	5.11E-3	4.95E-3	81	9.60E-2	1.03E-1	1.14E-1	1.31E-1	1.57E-1	1.87E-1
82	1.11E-2	9.69E-3	7.83E-3	5.90E-3	4.97E-3	4.83E-3	82	9.30E-2	9.98E-2	1.10E-1	1.26E-1	1.51E-1	1.81E-1
83	1.08E-2	9.42E-3	7.62E-3	5.74E-3	4.84E-3	4.71E-3	83	9.00E-2	9.64E-2	1.05E-1	1.22E-1	1.46E-1	1.75E-1
84	1.05E-2	9.16E-3	7.41E-3	5.59E-3	4.72E-3	4.59E-3	84	8.71E-2	9.29E-2	1.01E-1	1.18E-1	1.41E-1	1.69E-1
85	1.03E-2	8.92E-3	7.22E-3	5.44E-3	4.60E-3	4.48E-3	85	8.42E-2	8.94E-2	9.76E-2	1.14E-1	1.36E-1	1.64E-1
86	9.97E-3	8.68E-3	7.03E-3	5.30E-3	4.48E-3	4.37E-3	86	8.12E-2	8.60E-2	9.40E-2	1.10E-1	1.32E-1	1.59E-1
87	9.71E-3	8.45E-3	6.85E-3	5.17E-3	4.37E-3	4.27E-3	87	7.83E-2	8.28E-2	9.07E-2	1.07E-1	1.27E-1	1.54E-1
88	9.45E-3	8.23E-3	6.67E-3	5.04E-3	4.26E-3	4.17E-3	88	7.56E-2	7.98E-2	8.77E-2	1.03E-1	1.23E-1	1.49E-1
89	9.21E-3	8.02E-3	6.50E-3	4.91E-3	4.16E-3	4.08E-3	89	7.31E-2	7.72E-2	8.48E-2	1.00E-1	1.19E-1	1.44E-1
90	8.97E-3	7.82E-3	6.34E-3	4.79E-3	4.06E-3	3.98E-3	90	7.06E-2	7.48E-2	8.23E-2	9.69E-2	1.15E-1	1.40E-1
91	8.74E-3	7.62E-3	6.18E-3	4.68E-3	3.97E-3	3.90E-3	91	6.84E-2	7.25E-2	7.99E-2	9.38E-2	1.11E-1	1.35E-1
92	8.53E-3	7.43E-3	6.03E-3	4.56E-3	3.88E-3	3.81E-3	92	6.64E-2	7.04E-2	7.75E-2	9.07E-2	1.08E-1	1.31E-1

TABLE IX. Collision Strengths as a Function of Scattered Electron Energy E' for Na-Like ions

See page 11 for Explanation of Tables

$3p^* - 3d$							$3p^* - 3p$						
Z	$E'=0.0025$	$E'=0.015$	$E'=0.04$	$E'=0.10$	$E'=0.21$	$E'=0.40$	Z	$E'=0.0025$	$E'=0.015$	$E'=0.04$	$E'=0.10$	$E'=0.21$	$E'=0.40$
26	4.70E-2	4.29E-2	3.75E-2	3.22E-2	3.07E-2	3.17E-2	26	2.24E-1	2.11E-1	1.98E-1	1.87E-1	1.82E-1	1.80E-1
27	4.16E-2	3.80E-2	3.33E-2	2.86E-2	2.73E-2	2.82E-2	27	2.00E-1	1.89E-1	1.78E-1	1.68E-1	1.63E-1	1.62E-1
28	3.71E-2	3.39E-2	2.97E-2	2.56E-2	2.44E-2	2.53E-2	28	1.80E-1	1.71E-1	1.61E-1	1.52E-1	1.48E-1	1.47E-1
29	3.33E-2	3.04E-2	2.67E-2	2.30E-2	2.20E-2	2.28E-2	29	1.63E-1	1.55E-1	1.46E-1	1.38E-1	1.34E-1	1.33E-1
30	3.00E-2	2.75E-2	2.41E-2	2.08E-2	1.99E-2	2.07E-2	30	1.48E-1	1.41E-1	1.33E-1	1.26E-1	1.23E-1	1.22E-1
31	2.72E-2	2.49E-2	2.19E-2	1.89E-2	1.82E-2	1.89E-2	31	1.35E-1	1.29E-1	1.22E-1	1.15E-1	1.13E-1	1.12E-1
32	2.48E-2	2.27E-2	1.99E-2	1.73E-2	1.66E-2	1.73E-2	32	1.24E-1	1.18E-1	1.12E-1	1.06E-1	1.03E-1	1.03E-1
33	2.27E-2	2.08E-2	1.82E-2	1.58E-2	1.52E-2	1.59E-2	33	1.14E-1	1.09E-1	1.03E-1	9.78E-2	9.55E-2	9.50E-2
34	2.09E-2	1.91E-2	1.68E-2	1.46E-2	1.40E-2	1.46E-2	34	1.05E-1	1.00E-1	9.52E-2	9.05E-2	8.84E-2	8.80E-2
35	1.92E-2	1.76E-2	1.55E-2	1.35E-2	1.30E-2	1.35E-2	35	9.71E-2	9.30E-2	8.83E-2	8.40E-2	8.21E-2	8.17E-2
36	1.78E-2	1.63E-2	1.43E-2	1.25E-2	1.20E-2	1.26E-2	36	9.00E-2	8.63E-2	8.21E-2	7.82E-2	7.65E-2	7.61E-2
37	1.65E-2	1.51E-2	1.33E-2	1.16E-2	1.12E-2	1.17E-2	37	8.37E-2	8.04E-2	7.65E-2	7.29E-2	7.14E-2	7.11E-2
38	1.53E-2	1.40E-2	1.24E-2	1.08E-2	1.04E-2	1.09E-2	38	7.80E-2	7.50E-2	7.15E-2	6.82E-2	6.68E-2	6.65E-2
39	1.43E-2	1.31E-2	1.15E-2	1.01E-2	9.74E-3	1.02E-2	39	7.28E-2	7.01E-2	6.69E-2	6.39E-2	6.26E-2	6.24E-2
40	1.33E-2	1.22E-2	1.08E-2	9.42E-3	9.12E-3	9.55E-3	40	6.82E-2	6.57E-2	6.28E-2	6.00E-2	5.88E-2	5.87E-2
41	1.25E-2	1.15E-2	1.01E-2	8.83E-3	8.56E-3	8.97E-3	41	6.39E-2	6.16E-2	5.90E-2	5.64E-2	5.53E-2	5.52E-2
42	1.17E-2	1.07E-2	9.49E-3	8.30E-3	8.05E-3	8.44E-3	42	6.00E-2	5.80E-2	5.55E-2	5.31E-2	5.22E-2	5.21E-2
43	1.10E-2	1.01E-2	8.93E-3	7.82E-3	7.59E-3	7.96E-3	43	5.65E-2	5.46E-2	5.23E-2	5.01E-2	4.92E-2	4.92E-2
44	1.04E-2	9.52E-3	8.41E-3	7.37E-3	7.17E-3	7.52E-3	44	5.32E-2	5.15E-2	4.94E-2	4.74E-2	4.66E-2	4.66E-2
45	9.80E-3	8.99E-3	7.95E-3	6.97E-3	6.77E-3	7.12E-3	45	5.02E-2	4.86E-2	4.67E-2	4.49E-2	4.41E-2	4.41E-2
46	9.26E-3	8.50E-3	7.51E-3	6.59E-3	6.42E-3	6.75E-3	46	4.74E-2	4.60E-2	4.42E-2	4.25E-2	4.18E-2	4.19E-2
47	8.77E-3	8.05E-3	7.12E-3	6.25E-3	6.09E-3	6.41E-3	47	4.49E-2	4.35E-2	4.19E-2	4.03E-2	3.97E-2	3.98E-2
48	8.31E-3	7.63E-3	6.75E-3	5.93E-3	5.78E-3	6.09E-3	48	4.25E-2	4.13E-2	3.98E-2	3.83E-2	3.77E-2	3.79E-2
49	7.89E-3	7.24E-3	6.42E-3	5.64E-3	5.49E-3	5.80E-3	49	4.03E-2	3.92E-2	3.78E-2	3.64E-2	3.59E-2	3.61E-2
50	7.50E-3	6.89E-3	6.10E-3	5.37E-3	5.23E-3	5.53E-3	50	3.83E-2	3.73E-2	3.59E-2	3.47E-2	3.42E-2	3.44E-2
51	7.14E-3	6.56E-3	5.81E-3	5.12E-3	4.99E-3	5.28E-3	51	3.64E-2	3.54E-2	3.42E-2	3.31E-2	3.26E-2	3.28E-2
52	6.81E-3	6.25E-3	5.54E-3	4.88E-3	4.76E-3	5.04E-3	52	3.46E-2	3.38E-2	3.26E-2	3.15E-2	3.11E-2	3.14E-2
53	6.49E-3	5.97E-3	5.29E-3	4.66E-3	4.55E-3	4.82E-3	53	3.30E-2	3.22E-2	3.11E-2	3.01E-2	2.98E-2	3.00E-2
54	6.20E-3	5.70E-3	5.06E-3	4.46E-3	4.35E-3	4.62E-3	54	3.14E-2	3.07E-2	2.97E-2	2.88E-2	2.85E-2	2.87E-2
55	5.93E-3	5.45E-3	4.84E-3	4.27E-3	4.17E-3	4.42E-3	55	3.00E-2	2.93E-2	2.84E-2	2.75E-2	2.72E-2	2.75E-2
56	5.68E-3	5.22E-3	4.63E-3	4.09E-3	4.00E-3	4.24E-3	56	2.86E-2	2.80E-2	2.72E-2	2.63E-2	2.61E-2	2.64E-2
57	5.44E-3	5.00E-3	4.44E-3	3.92E-3	3.83E-3	4.07E-3	57	2.73E-2	2.68E-2	2.60E-2	2.52E-2	2.50E-2	2.53E-2
58	5.22E-3	4.80E-3	4.26E-3	3.76E-3	3.68E-3	3.91E-3	58	2.61E-2	2.56E-2	2.49E-2	2.42E-2	2.40E-2	2.43E-2
59	5.01E-3	4.60E-3	4.09E-3	3.61E-3	3.54E-3	3.77E-3	59	2.50E-2	2.45E-2	2.38E-2	2.32E-2	2.31E-2	2.34E-2
60	4.81E-3	4.42E-3	3.93E-3	3.47E-3	3.40E-3	3.63E-3	60	2.39E-2	2.35E-2	2.29E-2	2.23E-2	2.22E-2	2.25E-2
61	4.62E-3	4.25E-3	3.78E-3	3.34E-3	3.28E-3	3.49E-3	61	2.29E-2	2.25E-2	2.19E-2	2.14E-2	2.13E-2	2.16E-2
62	4.45E-3	4.09E-3	3.64E-3	3.21E-3	3.16E-3	3.37E-3	62	2.20E-2	2.16E-2	2.11E-2	2.06E-2	2.05E-2	2.09E-2
63	4.28E-3	3.94E-3	3.50E-3	3.10E-3	3.04E-3	3.25E-3	63	2.10E-2	2.07E-2	2.02E-2	1.98E-2	1.97E-2	2.01E-2
64	4.13E-3	3.80E-3	3.38E-3	2.99E-3	2.94E-3	3.14E-3	64	2.02E-2	1.99E-2	1.94E-2	1.90E-2	1.90E-2	1.94E-2
65	3.98E-3	3.66E-3	3.26E-3	2.88E-3	2.83E-3	3.03E-3	65	1.94E-2	1.91E-2	1.87E-2	1.83E-2	1.83E-2	1.87E-2
66	3.84E-3	3.53E-3	3.14E-3	2.78E-3	2.74E-3	2.93E-3	66	1.86E-2	1.84E-2	1.80E-2	1.76E-2	1.77E-2	1.81E-2
67	3.70E-3	3.41E-3	3.04E-3	2.69E-3	2.65E-3	2.84E-3	67	1.79E-2	1.77E-2	1.73E-2	1.70E-2	1.70E-2	1.74E-2
68	3.58E-3	3.30E-3	2.94E-3	2.60E-3	2.56E-3	2.75E-3	68	1.72E-2	1.70E-2	1.67E-2	1.64E-2	1.64E-2	1.69E-2
69	3.46E-3	3.19E-3	2.84E-3	2.51E-3	2.48E-3	2.66E-3	69	1.65E-2	1.63E-2	1.60E-2	1.58E-2	1.59E-2	1.63E-2
70	3.34E-3	3.08E-3	2.75E-3	2.43E-3	2.40E-3	2.58E-3	70	1.59E-2	1.57E-2	1.55E-2	1.52E-2	1.53E-2	1.58E-2
71	3.24E-3	2.98E-3	2.66E-3	2.36E-3	2.32E-3	2.50E-3	71	1.53E-2	1.52E-2	1.49E-2	1.47E-2	1.48E-2	1.52E-2
72	3.13E-3	2.89E-3	2.58E-3	2.28E-3	2.25E-3	2.43E-3	72	1.47E-2	1.46E-2	1.44E-2	1.42E-2	1.43E-2	1.48E-2
73	3.03E-3	2.80E-3	2.49E-3	2.21E-3	2.18E-3	2.36E-3	73	1.42E-2	1.41E-2	1.39E-2	1.37E-2	1.38E-2	1.43E-2
74	2.94E-3	2.71E-3	2.42E-3	2.15E-3	2.12E-3	2.29E-3	74	1.37E-2	1.35E-2	1.34E-2	1.33E-2	1.34E-2	1.39E-2
75	2.85E-3	2.63E-3	2.35E-3	2.08E-3	2.05E-3	2.22E-3	75	1.32E-2	1.31E-2	1.29E-2	1.28E-2	1.30E-2	1.34E-2
76	2.77E-3	2.55E-3	2.28E-3	2.02E-3	1.99E-3	2.16E-3	76	1.27E-2	1.26E-2	1.25E-2	1.24E-2	1.26E-2	1.30E-2
77	2.68E-3	2.48E-3	2.21E-3	1.96E-3	1.94E-3	2.10E-3	77	1.22E-2	1.22E-2	1.20E-2	1.20E-2	1.21E-2	1.26E-2
78	2.61E-3	2.41E-3	2.15E-3	1.91E-3	1.88E-3	2.05E-3	78	1.18E-2	1.17E-2	1.16E-2	1.16E-2	1.18E-2	1.23E-2
79	2.53E-3	2.34E-3	2.09E-3	1.85E-3	1.83E-3	1.99E-3	79	1.14E-2	1.13E-2	1.12E-2	1.12E-2	1.14E-2	1.19E-2
80	2.46E-3	2.27E-3	2.03E-3	1.80E-3	1.78E-3	1.94E-3	80	1.10E-2	1.09E-2	1.09E-2	1.09E-2	1.11E-2	1.15E-2
81	2.39E-3	2.21E-3	1.97E-3	1.75E-3	1.73E-3	1.89E-3	81	1.06E-2	1.06E-2	1.05E-2	1.05E-2	1.07E-2	1.12E-2
82	2.32E-3	2.15E-3	1.92E-3	1.70E-3	1.69E-3	1.84E-3	82	1.02E-2	1.02E-2	1.01E-2	1.02E-2	1.04E-2	1.09E-2
83	2.26E-3	2.09E-3	1.87E-3	1.66E-3	1.64E-3	1.79E-3	83	9.84E-3	9.84E-3	9.82E-3	9.85E-3	1.01E-2	1.06E-2
84	2.20E-3	2.03E-3	1.82E-3	1.62E-3	1.60E-3	1.75E-3	84	9.50E-3	9.50E-3	9.49E-3	9.54E-3	9.77E-3	1.03E-2
85	2.14E-3	1.98E-3	1.77E-3	1.57E-3	1.56E-3	1.70E-3	85	9.17E-3	9.18E-3	9.18E-3	9.24E-3	9.48E-3	9.99E-3
86	2.09E-3	1.93E-3	1.73E-3	1.53E-3	1.52E-3	1.66E-3	86	8.86E-3	8.87E-3	8.88E-3	8.95E-3	9.20E-3	9.71E-3
87	2.03E-3	1.88E-3	1.68E-3	1.50E-3	1.48E-3	1.62E-3	87	8.55E-3	8.57E-3	8.59E-3	8.67E-3	8.93E-3	9.44E-3
88	1.98E-3	1.83E-3	1.64E-3	1.46E-3	1.45E-3	1.59E-3	88	8.26E-3	8.28E-3	8.31E-3	8.40E-3	8.66E-3	9.17E-3
89	1.93E-3	1.79E-3	1.60E-3	1.42E-3	1.41E-3	1.55E-3	89	7.97E-3	8.00E-3	8.04E-3	8.14E-3	8.41E-3	8.92E-3
90	1.88E-3	1.74E-3	1.56E-3	1.39E-3	1.38E-3	1.51E-3	90	7.70E-3	7.73E-3	7.77E-3	7.89E-3	8.16E-3	8.68E-3
91	1.83E-3	1.70E-3	1.52E-3	1.35E-3	1.34E-3	1.48E-3	91	7.43E-3	7.47E-3	7.52E-3	7.64E-3	7.93E-3	8.44E-3
92	1.79E-3	1.66E-3	1.48E-3	1.32E-3	1.31E-3	1.44E-3	92	7.18E-3	7.22E-3	7.28E-3	7.41E-3	7.70E-3	8.21E-3

TABLE IX. Collision Strengths as a Function of Scattered Electron Energy E' for Na-Like ions

See page 11 for Explanation of Tables

$3p - 3d^*$							$3p - 3d$						
Z	$E'=0.0025$	$E'=0.015$	$E'=0.04$	$E'=0.10$	$E'=0.21$	$E'=0.40$	Z	$E'=0.0025$	$E'=0.015$	$E'=0.04$	$E'=0.10$	$E'=0.21$	$E'=0.40$
26	4.08E-1	4.41E-1	4.58E-1	5.32E-1	6.08E-1	6.89E-1	26	3.21E+0	3.53E+0	3.75E+0	4.46E+0	5.17E+0	5.88E+0
27	3.70E-1	3.99E-1	4.15E-1	4.81E-1	5.50E-1	6.23E-1	27	2.91E+0	3.20E+0	3.40E+0	4.04E+0	4.67E+0	5.32E+0
28	3.36E-1	3.62E-1	3.78E-1	4.38E-1	5.00E-1	5.67E-1	28	2.65E+0	2.92E+0	3.10E+0	3.68E+0	4.25E+0	4.84E+0
29	3.07E-1	3.31E-1	3.45E-1	4.00E-1	4.57E-1	5.18E-1	29	2.43E+0	2.67E+0	2.84E+0	3.36E+0	3.89E+0	4.43E+0
30	2.81E-1	3.03E-1	3.17E-1	3.67E-1	4.19E-1	4.76E-1	30	2.23E+0	2.45E+0	2.61E+0	3.09E+0	3.57E+0	4.07E+0
31	2.59E-1	2.79E-1	2.92E-1	3.37E-1	3.86E-1	4.38E-1	31	2.06E+0	2.26E+0	2.40E+0	2.84E+0	3.29E+0	3.75E+0
32	2.39E-1	2.58E-1	2.70E-1	3.12E-1	3.57E-1	4.06E-1	32	1.91E+0	2.09E+0	2.23E+0	2.63E+0	3.04E+0	3.47E+0
33	2.21E-1	2.39E-1	2.51E-1	2.89E-1	3.31E-1	3.77E-1	33	1.77E+0	1.94E+0	2.07E+0	2.44E+0	2.82E+0	3.23E+0
34	2.06E-1	2.22E-1	2.33E-1	2.69E-1	3.08E-1	3.51E-1	34	1.65E+0	1.80E+0	1.93E+0	2.27E+0	2.63E+0	3.00E+0
35	1.92E-1	2.07E-1	2.17E-1	2.51E-1	2.88E-1	3.28E-1	35	1.54E+0	1.68E+0	1.80E+0	2.12E+0	2.45E+0	2.81E+0
36	1.79E-1	1.93E-1	2.03E-1	2.35E-1	2.69E-1	3.07E-1	36	1.44E+0	1.57E+0	1.68E+0	1.98E+0	2.30E+0	2.63E+0
37	1.68E-1	1.81E-1	1.91E-1	2.20E-1	2.53E-1	2.88E-1	37	1.35E+0	1.47E+0	1.58E+0	1.85E+0	2.15E+0	2.46E+0
38	1.57E-1	1.70E-1	1.79E-1	2.07E-1	2.38E-1	2.71E-1	38	1.26E+0	1.38E+0	1.48E+0	1.74E+0	2.03E+0	2.32E+0
39	1.48E-1	1.60E-1	1.69E-1	1.95E-1	2.24E-1	2.55E-1	39	1.19E+0	1.30E+0	1.40E+0	1.64E+0	1.91E+0	2.19E+0
40	1.39E-1	1.51E-1	1.59E-1	1.83E-1	2.11E-1	2.41E-1	40	1.12E+0	1.23E+0	1.31E+0	1.55E+0	1.80E+0	2.06E+0
41	1.31E-1	1.42E-1	1.50E-1	1.73E-1	2.00E-1	2.28E-1	41	1.06E+0	1.16E+0	1.24E+0	1.46E+0	1.70E+0	1.95E+0
42	1.24E-1	1.35E-1	1.42E-1	1.64E-1	1.90E-1	2.16E-1	42	1.00E+0	1.09E+0	1.18E+0	1.38E+0	1.61E+0	1.85E+0
43	1.17E-1	1.27E-1	1.35E-1	1.56E-1	1.80E-1	2.05E-1	43	9.50E-1	1.03E+0	1.11E+0	1.31E+0	1.53E+0	1.75E+0
44	1.11E-1	1.21E-1	1.28E-1	1.48E-1	1.71E-1	1.95E-1	44	9.01E-1	9.81E-1	1.06E+0	1.24E+0	1.45E+0	1.67E+0
45	1.06E-1	1.15E-1	1.22E-1	1.41E-1	1.63E-1	1.86E-1	45	8.56E-1	9.31E-1	1.00E+0	1.18E+0	1.38E+0	1.59E+0
46	1.01E-1	1.09E-1	1.16E-1	1.34E-1	1.55E-1	1.77E-1	46	8.14E-1	8.86E-1	9.56E-1	1.12E+0	1.32E+0	1.51E+0
47	9.57E-2	1.04E-1	1.10E-1	1.28E-1	1.48E-1	1.69E-1	47	7.75E-1	8.43E-1	9.10E-1	1.07E+0	1.25E+0	1.44E+0
48	9.11E-2	9.90E-2	1.05E-1	1.22E-1	1.41E-1	1.62E-1	48	7.39E-1	8.03E-1	8.68E-1	1.02E+0	1.20E+0	1.38E+0
49	8.69E-2	9.44E-2	1.01E-1	1.16E-1	1.35E-1	1.55E-1	49	7.05E-1	7.66E-1	8.29E-1	9.76E-1	1.14E+0	1.32E+0
50	8.30E-2	9.02E-2	9.62E-2	1.11E-1	1.29E-1	1.48E-1	50	6.74E-1	7.31E-1	7.92E-1	9.33E-1	1.09E+0	1.26E+0
51	7.94E-2	8.63E-2	9.21E-2	1.07E-1	1.24E-1	1.42E-1	51	6.44E-1	6.98E-1	7.57E-1	8.93E-1	1.05E+0	1.21E+0
52	7.60E-2	8.26E-2	8.82E-2	1.02E-1	1.19E-1	1.37E-1	52	6.16E-1	6.68E-1	7.25E-1	8.55E-1	1.00E+0	1.16E+0
53	7.27E-2	7.91E-2	8.46E-2	9.82E-2	1.14E-1	1.31E-1	53	5.90E-1	6.39E-1	6.94E-1	8.19E-1	9.63E-1	1.11E+0
54	6.98E-2	7.59E-2	8.12E-2	9.43E-2	1.10E-1	1.26E-1	54	5.65E-1	6.12E-1	6.66E-1	7.86E-1	9.24E-1	1.07E+0
55	6.70E-2	7.28E-2	7.80E-2	9.06E-2	1.06E-1	1.22E-1	55	5.42E-1	5.87E-1	6.39E-1	7.54E-1	8.88E-1	1.03E+0
56	6.43E-2	7.00E-2	7.50E-2	8.72E-2	1.02E-1	1.17E-1	56	5.20E-1	5.63E-1	6.14E-1	7.25E-1	8.54E-1	9.87E-1
57	6.18E-2	6.73E-2	7.21E-2	8.39E-2	9.80E-2	1.13E-1	57	4.99E-1	5.40E-1	5.90E-1	6.97E-1	8.21E-1	9.50E-1
58	5.95E-2	6.47E-2	6.94E-2	8.09E-2	9.45E-2	1.09E-1	58	4.79E-1	5.19E-1	5.67E-1	6.70E-1	7.91E-1	9.15E-1
59	5.62E-2	6.41E-2	6.73E-2	7.67E-2	9.07E-2	1.05E-1	59	4.52E-1	5.02E-1	5.61E-1	6.37E-1	7.56E-1	8.81E-1
60	5.41E-2	6.18E-2	6.48E-2	7.41E-2	8.76E-2	1.02E-1	60	4.35E-1	4.82E-1	5.40E-1	6.14E-1	7.28E-1	8.50E-1
61	5.21E-2	5.96E-2	6.25E-2	7.16E-2	8.47E-2	9.82E-2	61	4.20E-1	4.63E-1	5.21E-1	5.92E-1	7.03E-1	8.20E-1
62	5.02E-2	5.75E-2	6.03E-2	6.91E-2	8.19E-2	9.50E-2	62	4.06E-1	4.46E-1	5.02E-1	5.71E-1	6.78E-1	7.92E-1
63	4.85E-2	5.55E-2	5.82E-2	6.69E-2	7.92E-2	9.20E-2	63	3.92E-1	4.29E-1	4.84E-1	5.51E-1	6.55E-1	7.65E-1
64	4.69E-2	5.36E-2	5.62E-2	6.47E-2	7.67E-2	8.91E-2	64	3.79E-1	4.13E-1	4.67E-1	5.32E-1	6.33E-1	7.40E-1
65	4.53E-2	5.18E-2	5.43E-2	6.26E-2	7.43E-2	8.64E-2	65	3.66E-1	3.98E-1	4.51E-1	5.14E-1	6.12E-1	7.16E-1
66	4.38E-2	5.01E-2	5.25E-2	6.07E-2	7.20E-2	8.38E-2	66	3.53E-1	3.84E-1	4.36E-1	4.97E-1	5.91E-1	6.93E-1
67	4.23E-2	4.85E-2	5.08E-2	5.88E-2	6.98E-2	8.13E-2	67	3.42E-1	3.70E-1	4.21E-1	4.81E-1	5.72E-1	6.71E-1
68	4.09E-2	4.69E-2	4.92E-2	5.70E-2	6.78E-2	7.90E-2	68	3.31E-1	3.57E-1	4.07E-1	4.66E-1	5.54E-1	6.50E-1
69	3.96E-2	4.54E-2	4.77E-2	5.53E-2	6.58E-2	7.67E-2	69	3.21E-1	3.45E-1	3.94E-1	4.51E-1	5.36E-1	6.30E-1
70	3.84E-2	4.40E-2	4.62E-2	5.37E-2	6.39E-2	7.45E-2	70	3.11E-1	3.33E-1	3.82E-1	4.36E-1	5.19E-1	6.11E-1
71	3.72E-2	4.27E-2	4.48E-2	5.21E-2	6.20E-2	7.25E-2	71	3.01E-1	3.22E-1	3.69E-1	4.23E-1	5.03E-1	5.93E-1
72	3.61E-2	4.14E-2	4.34E-2	5.06E-2	6.03E-2	7.05E-2	72	2.92E-1	3.11E-1	3.58E-1	4.10E-1	4.88E-1	5.75E-1
73	3.50E-2	4.01E-2	4.22E-2	4.92E-2	5.86E-2	6.86E-2	73	2.83E-1	3.01E-1	3.46E-1	3.97E-1	4.73E-1	5.58E-1
74	3.40E-2	3.90E-2	4.09E-2	4.78E-2	5.70E-2	6.68E-2	74	2.75E-1	2.91E-1	3.36E-1	3.86E-1	4.59E-1	5.42E-1
75	3.30E-2	3.78E-2	3.98E-2	4.65E-2	5.55E-2	6.50E-2	75	2.67E-1	2.82E-1	3.26E-1	3.74E-1	4.46E-1	5.27E-1
76	3.20E-2	3.67E-2	3.86E-2	4.53E-2	5.40E-2	6.34E-2	76	2.60E-1	2.73E-1	3.16E-1	3.63E-1	4.33E-1	5.12E-1
77	3.11E-2	3.57E-2	3.76E-2	4.40E-2	5.26E-2	6.18E-2	77	2.52E-1	2.64E-1	3.06E-1	3.53E-1	4.21E-1	4.98E-1
78	3.02E-2	3.47E-2	3.65E-2	4.29E-2	5.13E-2	6.02E-2	78	2.45E-1	2.56E-1	2.97E-1	3.43E-1	4.09E-1	4.84E-1
79	2.94E-2	3.37E-2	3.55E-2	4.18E-2	5.00E-2	5.88E-2	79	2.38E-1	2.49E-1	2.88E-1	3.33E-1	3.97E-1	4.71E-1
80	2.86E-2	3.28E-2	3.46E-2	4.07E-2	4.87E-2	5.73E-2	80	2.31E-1	2.41E-1	2.80E-1	3.23E-1	3.86E-1	4.58E-1
81	2.78E-2	3.19E-2	3.36E-2	3.97E-2	4.75E-2	5.60E-2	81	2.25E-1	2.34E-1	2.72E-1	3.14E-1	3.76E-1	4.46E-1
82	2.71E-2	3.11E-2	3.28E-2	3.87E-2	4.63E-2	5.47E-2	82	2.18E-1	2.28E-1	2.64E-1	3.06E-1	3.65E-1	4.35E-1
83	2.63E-2	3.03E-2	3.19E-2	3.77E-2	4.52E-2	5.34E-2	83	2.12E-1	2.22E-1	2.56E-1	2.97E-1	3.55E-1	4.23E-1
84	2.56E-2	2.95E-2	3.11E-2	3.68E-2	4.41E-2	5.22E-2	84	2.06E-1	2.16E-1	2.49E-1	2.89E-1	3.46E-1	4.12E-1
85	2.50E-2	2.87E-2	3.03E-2	3.59E-2	4.31E-2	5.10E-2	85	2.01E-1	2.10E-1	2.42E-1	2.82E-1	3.37E-1	4.02E-1
86	2.44E-2	2.80E-2	2.95E-2	3.50E-2	4.21E-2	4.99E-2	86	1.95E-1	2.04E-1	2.35E-1	2.74E-1	3.28E-1	3.92E-1
87	2.38E-2	2.73E-2	2.88E-2	3.42E-2	4.11E-2	4.88E-2	87	1.90E-1	1.99E-1	2.29E-1	2.67E-1	3.20E-1	3.82E-1
88	2.32E-2	2.66E-2	2.81E-2	3.34E-2	4.02E-2	4.77E-2	88	1.84E-1	1.94E-1	2.22E-1	2.60E-1	3.11E-1	3.73E-1
89	2.26E-2	2.59E-2	2.74E-2	3.26E-2	3.93E-2	4.67E-2	89	1.79E-1	1.90E-1	2.16E-1	2.53E-1	3.04E-1	3.64E-1
90	2.20E-2	2.53E-2	2.68E-2	3.19E-2	3.84E-2	4.57E-2	90	1.74E-1	1.85E-1	2.10E-1	2.47E-1	2.96E-1	3.55E-1
91	2.15E-2	2.47E-2	2.61E-2	3.12E-2	3.76E-2	4.47E-2	91	1.70E-1	1.81E-1	2.05E-1	2.41E-1	2.89E-1	3.47E-1
92	2.09E-2	2.41E-2	2.55E-2	3.05E-2	3.67E-2	4.38E-2	92	1.65E-1	1.77E-1	1.99E-1	2.35E-1	2.81E-1	3.39E-1