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Gapenski, Louis Charles

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PREDICTIONS OF ATOMIC ENERGY LEVELS BY EXTRAPOLATION ALONG ISOELECTRONIC SEQUENCES: HELIUM THROUGH SODIUM

by

Louis Charles Gapenski

United States Naval Postgraduate School

THESIS

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BY EXTRAPOLATION ALONG

ISOELECTRONIC SEQUENCES: HELIUM THROUGH SODIUM

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Louis Charles Gapenski

Major, United States Marine Corps

B.S., Virginia Military Institute, 1959

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ABSTRACT

Approximately 900 unknown atomic energy levels were predicted by extrapolation along the helium through sodium isoelectronic sequences. The extrapolations, based on well known regularities in atomic spectra, extend beyond the range of known values providing predictions in highly ionized atoms. The predicted energy levels are presented, along with the known values, in tabular form. In addition, as an aid to spectroscopists, 116 transitions are listed with known and predicted wavelengths. Since the majority of the energy level predictions are in highly ionized atoms, most of the predicted wavelengths fall in the vacuum ultraviolet region of the spectrum.

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I. INTRODUCTION

Identified atomic energy levels provide an indispensable tool for scientists in many fields. Scientists in astrophysics, plasma physics, physical chemistry, atomic physics and nuclear physics as well as many related fields rely heavily on the proper identification of atomic energy levels and the corresponding transition values.

The first decisive step towards a systematic description of atomic spectra was taken by Rydberg, who published his findings in 1890. In the 80 years following, great progress has been made in the identification and classification of atomic energy levels. An excellent selection of papers of historical interest may be found in a recent book by Hindmarsh [1]. The first major attempt to compile the identified levels resulted in the 1932 publication of Bacher and Goudsmit [2]. Work continued in spectral analysis and soon the number of identified levels increased many fold. A more recent compilation of levels was completed by Moore [487] in 1958.[1]

Although tens of thousands of levels are now identified, great gaps exist in our knowledge. Some spectra are incompletely analyzed and others have no identified levels at all. A logical extension of our knowledge would be to fill these gaps in order to provide this information for all users.

The indispensable means of energy level identification is analysis of experimentally obtained atomic spectra. The experiments on highly ionized atoms present difficulties which, in some cases, are almost impossible to overcome. In any event, it is helpful to the spectroscopist to have an estimate of the transition wavelength to plan optimum use of

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[1] Use of a previously established reference system precludes numbering of references in order of occurrence.

the experimental equipment and to aid in line identification. This estimate or prediction may be obtained by two methods. One approach would be to calculate the energy levels using, for example, the Hartree-Fock method. A thorough treatment of this method is given by Slater [3]. The Hartree-Fock method is extremely complex for all but the most simple atoms and yields results of insufficient accuracy. If exact values could be obtained by this method, the complexity of calculations would not be a deterrent.

The second means of energy level prediction is that of extrapolation or interpolation among known values. The validity of this procedure is based on well known regularities in atomic spectra. Extrapolations are relatively easy to do in routine fashion but have the disadvantage that extensions can be made only along levels which have previously identified values. The remainder of this thesis is devoted to the details of this method and results obtained.

II. THEORY

This section is not indended to be a comprehensive discussion of atomic physics. The purpose is to review those concepts which apply directly to the extrapolation procedures used. A more detailed discussion of atomic structure can be found in many texts, including Herzberg [4], Kuhn [5], White [6] and Edlén [7].

A. ISOELECTRONIC SEQUENCES

The name isoelectronic sequence is used to describe a sequence of an atom and ions having the same number of electrons. The sequence may start at any atom in the periodic table; for example, lithium. The neutral lithium atom with three electrons is designated Li I and its spectrum is frequently called the arc spectrum. The next heavier atom in the periodic table is beryllium. Since beryllium has four electrons, the removal of

one electron will leave the same number as Li I. This beryllium ion is designated Be II and its spectrum is called the first spark spectrum. The next heavier atom is boron. To make boron isoelectronic with Li I and Be II two electrons must be removed. This is designated B III and its spectrum is called the second spark spectrum. The isoelectronic sequence continues in the same manner throughout the periodic table. Since the sequence started with the neutral lithium atom it is called the lithium isoelectronic sequence. The roman numeral following the element is called the spectrum number.

B. SPECTRAL NOTATION

1. One-Electron Systems

Quantum theory provides a means for specifying the external state of the atom. The quantum numbers n (principal), ℓ (orbital angular momentum), s (spin) and j (total angular momentum) are used to specify the possible states. The quantity (2s + 1) is called the multiplicity and represents the number of values of j. It is common to use letters to specify the value of ℓ. These letters correspond to the numerical values: s = 0, p = 1, d = 2, f = 3, g = 4 and down the alphabet skipping the letter j. The quantum numbers are not independent but are related as follows:

$$n = 1, 2, 3, \ldots.$$

$$\ell = 0, 1, 2, \ldots. (n - 1)$$

$$s = \tfrac{1}{2}$$

$$j = \ell \pm s = \ell \pm \tfrac{1}{2} \text{ but must be} > 0$$

A typical notation is:

$$3^2 P_{3/2}$$

which means that:

$$n = 3$$

multiplicity = 2

$\ell = 1$

$j = 3/2$

2. <u>Multielectron Systems</u>

In the multielectron system each electron is described by a set of quantum numbers as discussed above. It is necessary to combine or couple the angular momenta described by the quantum numbers to form a representation of the entire system. Different assumptions about the manner of coupling lead to several coupling schemes. Few atoms satisfy completely the conditions for any one coupling scheme, so the one chosen represents only an approximation of the true coupling. The coupling schemes are labeled in a way which denotes the least important interaction among the several angular momenta.

a. L - S Coupling

L - S (or Russell-Saunders) coupling is used almost exclusively in this paper and, therefore, will be stressed. In the vector model of the atom, L - S coupling describes the case where the individual spins couple strongly among themselves, as do the orbital angular momenta. The spin-orbit interaction of the resultants is much weaker. Such coupling arises from the predominance of electrostatic over magnetic interactions, which is the case in light atoms. For this situation, the same notation can be used as for one-electron systems except that the capital letters S, L, and J refer to the resultant of the individual components. The actual process of determining the values of S, L, and J for a given electron configuration is too lengthly to present here. When equivalent electrons are involved, the Pauli exclusion principle limits the number of possible states. Let it suffice to give a typical notation example:

$$1s^2 2s^2 2p^2 \quad {}^3P_0$$

This represents a system of six electrons with the configuration $1s^2 2s^2 2p^2$. The state of the atom is described by the term ${}^3P_0$ which means that:

$$2S + 1 = 3 \text{ or } S = 1$$

$$L = 1$$

$$J = 0$$

This is only one of five possible terms (${}^3P_0$, ${}^3P_1$, ${}^3P_2$, ${}^1D_2$, ${}^1S_0$) arising from this configuration.

b. Other Coupling

If the spin-orbit interactions are large compared with the electrostatic interactions, as in heavy atoms, j-j coupling becomes dominant. Numerous schemes fall in the region intermediate between L - S and j-j coupling. Among these are those labeled j - K and L - K, where K is the quantum number of the atom's angular momentum (exclusive of the spin of the outermost electron).

3. Parent Terms

In most configurations, it is impossible to describe the state of a multielectron system uniquely with a single term. In such cases it is necessary to designate the parent term. As an example, consider the nitrogen atom, with seven electrons. If an electron is removed to form the ion, the ground configuration of the ion is $1s^2 2s^2 2p^2$. If an electron is added now to the parent ion in this configuration, it might go into a configuration $1s^2 2s^2 2p^2 3p$. Since, however, the ion could have been in a state described by ${}^3P_0$, ${}^3P_1$, ${}^3P_2$, ${}^1S_0$, or ${}^1D_2$, the state of the atom will be different (the energy levels different) depending on the state of the parent ion. We describe the state of the atom by including the parent term, as $1s^2 2s^2 2p^2 ({}^3P_0) 3p \ {}^2P_{\frac{1}{2}}$ or $1s^2 2s^2 2p^2 ({}^1S_0) 3p \ {}^2P_{\frac{1}{2}}$.

4. <u>Parity</u>

If the wave function is reflected through the origin, the function is found to be either unchanged or changed in sign only. The function is accordingly called even or odd. This property, which is defined for every atomic state, is parity. The parity can be determined from the configuration. If the sum of all ℓ's is even or odd, the parity is correspondingly even or odd. Odd parity is designated by a superscript ^{o} on the term, for example $^{3}P_{1}^{o}$.

C. TERM RELATIONSHIPS

Since members of an isoelectronic sequence contain the same number of electrons, we expect the term systems to be identical except for the numerical values of the terms. Thus, it should be possible to predict values along a sequence from the known values if a suitable extrapolation formula can be found.

1. <u>One-Electron Systems</u>

One-electron systems are called hydrogenic since the electron configuration resembles that of hydrogen. The relativistic quantum treatment of the one-electron system leads to the following expression for the term energy T:

$$T_{n,\ell,j} = \frac{RchZ^2}{n^2} + \frac{Rch\alpha^2 Z^4}{n^3}\left(\frac{1}{\ell + \frac{1}{2}} - \frac{3}{4n}\right) - \frac{Rch\alpha^2 Z^4}{n^3} \left(\frac{j(j+1) - \ell(\ell+1) - s(s+1)}{\ell(2\ell+1)(\ell+1)}\right) \quad (1)$$

where:

R = Rydberg constant

c = velocity of light

h = Planck's constant

α = fine structure constant

The first term in equation (1) is the Bohr expression for the term energy; the second term, the relativity correction; and the third term the spin-orbit interaction correction. For each term in the hydrogen isoelectronic sequence the only variable in equation (1) is Z. Quantum theory provides exactly the term energy values for the hydrogen isoelectronic sequence; therefore, the hydrogen sequence is of little interest for extrapolation, but equation (1) is quite important in the application to multielectron systems.

2. <u>Multielectron Systems</u>

In multielectron systems it is necessary to introduce the concept of effective nuclear charge, $Z - \sigma$, where σ is the screening constant. The screening constant accounts for the fact that in multielectron systems the outer electrons are not subjected to full electrostatic attraction by the nucleus; part of the nuclear charge is screened by the inner core electrons. Substituting $Z - \sigma$ for Z in equation (1) gives a fourth degree polynomial in Z, assuming σ is independent of Z. Actually, σ is only approximately independent of Z but approaches true constancy for large Z.

3. <u>Energy Level versus Term Value</u>

The previous discussion applies to term value, which represents the energy of the system with respect to the ionization limit. The ionization energy is assigned a value of zero and the term value is measured down from the ionization limit. The energy level corresponding to the term value is customarily measured with respect to the ground state. The ground state is assigned a value of zero and the energy level is the value above the ground state. Thus the energy level is merely the ionization energy minus the term value. Since the ionization energy is expected to demonstrate a Z^4 dependence, it should be possible to express the energy level by a fourth degree polynomial in Z with appropriate changes in coefficients.

D. RELATIVE TERM VALUES

Quantum mechanics provides formulae giving the relative positions of terms for a given configuration. This knowledge is very useful as a guide in empirical analysis. The following discussion applies only to L-S coupling.

1. Terms of Different L and S

A useful rule is that the lowest level of a given configuration of equivalent electrons (same n and l) is that with the largest value of S, and, if there are several of these, that with the largest value of L. This relationship, known as Hund's rule, is generally confirmed by observations on ground configurations, but many exceptions exist in excited configurations. The important fact to note is that regularities do exist which can be used as an aid in extrapolation. It is not necessary to rely solely on theory in extrapolation, however, as known values should provide the proper relationships.

2. Multiplet Structure

A multiplet is a set of levels characterized by the same values of L and S, but differing in values of J. The effect giving rise to multiplet structure is the spin-orbit term in equation (1). A doublet has two allowed J values, a triplet has three allowed J values, etc. If the energy of the levels increases with increasing J, the multiplet is described as normal. This is usually the case if the unfilled sub-shell is less than half filled. If the energy of the levels decreases with increasing J, the multiplet in inverted. This is usually the case if the sub-shell is more than half filled. For normal multiplets, the multiplet spacing tends to obey an interval rule which was first found empirically by Landé. It states that in a normal multiplet the differences between adjacent levels are in the ratio of their J values, where for each interval the higher of the two

J values is to be taken. Thus, the energy differences $^3P_2$ - $^3P_1$ and $^3P_1$ - $^3P_0$ are in the ratio 2:1. The Landé interval rule can be used to obtain the energy level of a multiplet member if the other members are known.

E. PERTURBATIONS

The regular arrangement of term values is sometimes found to be disturbed. Deviations from the position expected by simple theory are called perturbations. One type of perturbation which is well defined is the so-called configuration interaction. Under certain conditions, terms belonging to different electron configurations will perturb each other. This occurs when both electron configurations are of the same parity and both terms have the same J value. In addition, in L-S coupling, observation shows that the greatest effect is to be expected when the two terms have the same L and S values.

F. TRANSITIONS

The term value or energy level is not an experimentally measureable quantity. However, the energy difference between energy levels may be obtained experimentally by spectroscopic measurements. The change from one level to another is called a transition. Transitions cannot occur arbitrarily between levels but are restricted in dipole radiation. These restrictions or selection rules are as follows:

$$\Delta \ell = \pm 1 \text{ (Parity Change)}$$

$$\Delta J = 0, \pm 1 \text{ but } J = 0 \rightarrow J = 0 \text{ is forbidden}$$

$$\Delta L = 0, \pm 1$$

$$\Delta S = 0$$

The last two conditions are valid only to the extent that L-S coupling is a valid approximation. As we move further into intermediate coupling these rules are violated with greater frequency. A transition with $\Delta S \neq 0$ is

called an intercombination transition. These are quite weak in the spectra of light elements but become fairly strong in the heavy elements. The condition for ΔJ holds in any coupling. The selection rules forbidding dipole transitions between terms of the same parity holds for all coupling schemes.

III. EXTRAPOLATION PROCEDURES

A. INPUT DATA

1. Sources

Over the past several years Professor R. L. Kelly has conducted an extensive publications search collecting energy level data. The starting point was Moore [487] but hundreds of other references were used. This compilation continues today, as pertinent articles appear continuously in scientific journals. The data are stored in punch card format, with a card made for each energy level for which a value is known. Each card contains the following data:

Element

Spectrum Number

Atomic Number

Configuration and Term Description

Energy Level Value

Uncertainty Indicator

Reference Number

2. Isoelectronic Sequence Term Listing

The initial step requires the organization of the energy level data in a manner which simplifies the selection of sequences to be investigated. A short program was written which lists the energy level cards for each term of the isoelectronic sequence. If the cards are input in ascending

order within the isoelectronic sequence, the listing by term is also in ascending order. This listing shows which terms have many identified levels and which terms have few.

B. EXTENT OF INVESTIGATION

It was obvious at the outset that the time available would limit the isoelectronic sequences that could be examined. It was also necessary to limit the terms extrapolated within each isoelectronic sequence.

1. Isoelectronic Sequences

Because the hydrogen isoelectronic sequence is known completely, a logical starting point was the helium isoelectronic sequence. Investigation of ten isoelectronic sequences was selected as a reasonable goal. This encompassed all isoelectronic sequences from helium through sodium.

2. Terms

The isoelectronic sequence term listing was used to select terms to be extrapolated. (It should be noted here that some predictions are actually interpolations but the term extrapolation will be used in all cases.) Obviously, five known energy level values are required to obtain a unique fourth degree fit. In most cases, then, only those terms with five or more known energy levels were extrapolated. (In rare cases extrapolations were performed where three or four energy levels were known. In these cases only a second degree fit was used.) A further reduction was to consider only terms with configurations having all electrons with $n \leq 5$.

C. EXTRAPOLATION PROGRAM

The program used to perform the extrapolations was a standard least-squares polynomial fit routine coupled with a plot routine. Input to the program consists of the atomic number and energy level value of the known

isoelectronic sequence members. The least-squares fit routine computes the polynomial coefficients and all energy level values up to $Z = 30$, the upper limit selected. The plot routine plots the known input points and superimposes over these the polynomial which gave the best fit. The program was restricted to the first through fourth degrees.

D. EXTRAPOLATION DECISIONS

1. Degree Used

The first thing examined was the sign and magnitude of the coefficients. If the coefficient of Z^4 was negative, the fourth degree extrapolation was discarded, as theory does not support such a relationship. Next, the coefficient of Z^2 was examined. In rare cases this was also negative. In every case in which both second and fourth degree coefficients were negative, the polynomial plot indicated a possible first degree dependence. This is theoretically possible as the subtraction of the term value equation from the ionization energy equation could cause the higher order coefficients to vanish. In these cases the first degree fit was used for extrapolation. If the coefficient of Z^4 was negative, but the coefficient of Z^2 positive, the second degree fit was used. (Perturbations and/or incorrect input values were assumed to be responsible as the fourth degree fit is much more sensitive.) If the coefficient of Z^4 was positive it was checked for magnitude. In equation (1), the fourth degree terms contain α^2, a very small number. Thus, the coefficient of Z^4 should be much smaller than the coefficient of Z^2. If this were not true, the second degree fit was used. Again, perturbations and/or incorrect input values could have caused the unduly large Z^4 coefficient.

2. Validity of Values

After selecting the degree the output was examined for curve fit. Naturally, the better the fit, the more confidence placed on the extrapolations.

Curve fits ranged from good to marginal. If the input values had eight significant figures, good curve fits agreed with input values to about six significant figures while marginal fits agreed to about four. The extrapolated values were only carried to a number of significant figures which agreed with the input values. Relationships other than extrapolations were used to verify values In multiplets, the Lande interval rule, when applicable, was used as a check. In singlets, comparison was made with other singlets or with the corresponding multiplet, if present, to insure continuation of relationships established in the input values. Violations were treated on an individual basis; in some cases the extrapolation was used for prediction, in others, the interval estimation was used.

3. Extent of Extrapolation

The number of values obtained from a given extrapolation was somewhat arbitrary, although the limit at Z = 30 was followed throughout. Presuming a constant percentage of correct input values, the greater the input the more valid the extrapolation. Thus, a general guide followed was to predict one value for every three input values. This guide was not followed when there were only a few known values or when the fit was exceptionally good.

IV. RESULTS

The results are expressed in tables of two forms. Tables I, III, V, ... XIX list the terms within each isoelectron sequence for which extrapolations were carried out. The columns present, from left to right: Element, spectrum number, atomic number, energy level value in reciprocal centimeters, and reference. Extrapolated values are enclosed in parentheses and can be further identified by the reference numbers 374 or 375. Those known values which have an uncertainty caused by doubtful identification or by lack of connection with the ground state are indicated by asterisks. In those cases where the extrapolated values differ significantly from the known values, and yet the extrapolation appears valid, the extrapolation value was listed along with the known value. Also, in cases where the multiplet could be resolved by the extrapolation, the extrapolated value was listed along with the unresolved value. All levels are designated by L-S notation. Since these tables are computer output, certain deviations from standard notation were necessary. Subscripts, superscripts and roman numerals were not used; therefore, all numbering falls on the line and arabic numbers are used throughout. Also fractions were not used, and fractional J values are represented by the next higher whole number. Finally, an asterisk is used to represent odd parity.

Tables II, IV, ... XX list selected transitions within each isoelectronic sequence. The tables are presented as an aid to the spectroscopist who deals with transitions rather than energy levels. The transitions are listed down the left margin and the sequence members across the top. Those transitions involving at least one predicted level are indicated by parentheses. It is impractical to list all conceivable transitions so representative transitions which follow normal selection rules are listed.

V. CONCLUSIONS

The test of the extrapolation procedures is the determination of how well the extrapolated levels compare with those deduced from observed transitions. Two recent papers list some energy levels or transitions involving energy levels which had been included in this project.

Tondello [776] observed transitions in the Si XI and Si XII spectrum using a laser produced plasma. To aid in line identification, he also used extrapolation techniques to predict transitions. Table XXI compares his work with predictions of this project. There is reasonably good agreement between the two sets of values, the wavelengths agreeing to within 0.1 Angstrom.

Gruzdev [GR69] calculated energy levels of the $2p^4$ and $2p^3 3s$ configurations in the spectra of the oxygen isoelectronic sequence from O I through Fe XIX, using the method of intermediate coupling in the single configuration approximation. Table XXII compares his work with extrapolations of this project. Within the $2p^4$ configuration the agreement is poor. The agreement within the $2p^3 3s$ configuration is much better, with less than one percent difference in all cases. Comparison by Gruzdev of his calculations against experimental values exhibited the same trend, that is, much better agreement in the $2p^3 3s$ configuration.

Of the 48 values compared against other sources 32 were within one percent difference. We conclude that it is possible, using extrapolation procedures, to predict energy levels with an accuracy that permits their use to first approximation. Certainly a first approximation is better than no approximation.

TABLE I HELIUM ISOELECTRONIC SEQUENCE

1S ( ) 2S 3S 1

HE	1	2	159856.069	497
LI	2	3	476034.98	307
BE	3	4	*956496.*	487
B	4	5	1601505.	487
C	5	6	2411266.	487
N	6	7	3385850.	072
O	7	8	4525340.	487
F	8	9	5829920.	487
NE	9	10	*7295900.*	373
NA	10	11	(8931000.)	374
MG	11	12	(10729000.)	374
AL	12	13	(12692000.)	374
SI	13	14	(14819000.)	374

1S ( ) 2S 1S 0

HE	1	2	166277.546	497
LI	2	3	491374.6	775
BE	3	4	(981100.)	374
B	4	5	(1635500.)	374
C	5	6	(2454500.)	374
N	6	7	(3438500.)	374
O	7	8	(4586500.)	374
F	8	9	5899720.	373
NE	9	10	(7377500.)	374

1S ( ) 2P 3P* 0

HE	1	2	169087.9280	497
LI	2	3	494266.57	307
BE	3	4	(983340.)	375
B	4	5	1636898.	487
C	5	6	2455165.	487
N	6	7	3438270.	487
O	7	8	4586330.	202
F	8	9	*5899150.*	487
NE	9	10	7380600.	559
NA	10	11	9025300.	709
MG	11	12	10834200.	709
AL	12	13	(12810000.)	374
SI	13	14	(14950000.)	374
P	14	15	(17270000.)	374
S	15	16	(19760000.)	374
CL	16	17	(22420000.)	374
AR	17	18	25233400.	559
K	18	19	28250000.	144
CA	19	20	31350000.	144
SC	20	21	34720000.	144
TI	21	22	38170000.	144
V	22	23	41670000.	144
CR	23	24	45660000.	144
MN	24	25	49500000.	144
FE	25	26	53760000.	144
CO	26	27	58140000.	144
NI	27	28	62500000.	144
CU	28	29	67110000.	144
ZN	29	30	71940000.	144

TABLE I HELIUM ISOELECTRONIC SEQUENCE (cont.)

1S ( ) 2P 3P* 1

HE	1	2	169086.9400	497
LI	2	3	494261.17	307
BE	3	4	*983348.*	487
B	4	5	1636882.	487
C	5	6	2455152.	487
N	6	7	3438280.	487
O	7	8	4586390.	202
F	8	9	5899310.	487
NE	9	10	7380600.	559
NA	10	11	9025300.	709
MG	11	12	10834200.	709
AL	12	13	(12810000.)	374
SI	13	14	(14950000.)	374
P	14	15	(17270000.)	374
S	15	16	(19760000.)	374
CL	16	17	(22420000.)	374
AR	17	18	25233400.	559
K	18	19	28250000.	144
CA	19	20	31350000.	144
SC	20	21	34720000.	144
TI	21	22	38170000.	144
V	22	23	41670000.	144
CR	23	24	45660000.	144
MN	24	25	49500000.	144
FE	25	26	53760000.	144
CO	26	27	58140000.	144
NI	27	28	62500000.	144
CU	28	29	67110000.	144
ZN	29	30	71940000.	144

1S ( ) 2P 3P* 2

HE	1	2	169086.8636	497
LI	2	3	494263.44	307
BE	3	4	*983363.*	487
B	4	5	1636934.	487
C	5	6	2455288.	487
N	6	7	3438570.	487
O	7	8	4586940.	202
F	8	9	*5900260.*	487
NE	9	10	7380600.	559
NA	10	11	9025300.	709
MG	11	12	10834200.	709
AL	12	13	(12810000.)	374
SI	13	14	(14950000.)	374
P	14	15	(17270000.)	374
S	15	16	(19760000.)	374
CL	16	17	(22420000.)	374
AR	17	18	25233400.	559
K	18	19	28250000.	144
CA	19	20	31350000.	144
SC	20	21	34720000.	144
TI	21	22	38170000.	144
V	22	23	41670000.	144
CR	23	24	45660000.	144
MN	24	25	49500000.	144
FE	25	26	53760000.	144
CO	26	27	58140000.	144
NI	27	28	62500000.	144
CU	28	29	67110000.	144
ZN	29	30	71940000.	144

TABLE I HELIUM ISOELECTRONIC SEQUENCE (cont.)

1S ( ) 2P 1P* 1

HE	1	2	171135.000	497
LI	2	3	501808.59	307
BE	3	4	997466.	487
B	4	5	1658020.	487
C	5	6	2483240.	487
N	6	7	3473790.	487
O	7	8	4629200.	487
F	8	9	5949900.	487
NE	9	10	7436600.	559
NA	10	11	9090900.	709
MG	11	12	10907300.	487
AL	12	13	12891900.	236
SI	13	14	(15040000.)	374
P	14	15	(17350000.)	374
S	15	16	(19830000.)	374
CL	16	17	(22470000.)	374
AR	17	18	25355000.	559
K	18	19	28250000.	144
CA	19	20	31350000.	144
SC	20	21	34720000.	144
TI	21	22	38170000.	144
V	22	23	41670000.	144
CR	23	24	45660000.	144
MN	24	25	49500000.	144
FE	25	26	53760000.	144
CO	26	27	58140000.	144
NI	27	28	62500000.	144
CU	28	29	67110000.	144
ZN	29	30	71940000.	144

1S ( ) 3S 3S 1

HE	1	2	183236.892	497
LI	2	3	554754.45	307
BE	3	4	(1121500.)	374
B	4	5	(1882500.)	374
C	5	6	(2839000.)	374
N	6	7	(3991000.)	374
O	7	8	5337070.	555
F	8	9	(6878500.)	374
NE	9	10	(8615000.)	374

1S (   ) 3P   3P* 0

HE	1	2	185564.9466	497
LI	2	3	559502.32	307
BE	3	4	(1128000.)	374
B	4	5	(1892000.)	374
C	5	6	2851370.	262
N	6	7	4006120.	262
O	7	8	5356380.	487
F	8	9	6897570.	373
NE	9	10	*8640000.*	262
NA	10	11	(10580000.)	374
MG	11	12	(12710000.)	374
AL	12	13	(15060000.)	374
SI	13	14	(17600000.)	374
P	14	15	(20330000.)	374
S	15	16	(23240000.)	374
CL	16	17	(26340000.)	374
AR	17	18	29670000.	144
K	18	19	33110000.	144
CA	19	20	36760000.	144
SC	20	21	40650000.	144
TI	21	22	44840000.	144
V	22	23	49020000.	144
CR	23	24	53480000.	144
MN	24	25	58140000.	144
FE	25	26	62890000.	144
CO	26	27	68030000.	144
NI	27	28	73530000.	144
CU	28	29	78740000.	144
ZN	29	30	84750000.	144

1S (   ) 3P   3P* 1

HE	1	2	185564.6760	497
LI	2	3	559500.35	307
BE	3	4	(1128000.)	374
B	4	5	(1892000.)	374
C	5	6	2851370.	262
N	6	7	4006120.	262
O	7	8	5356380.	487
F	8	9	6897570.	373
NE	9	10	*8640000.*	262
NA	10	11	(10580000.)	374
MG	11	12	(12710000.)	374
AL	12	13	(15060000.)	374
SI	13	14	(17600000.)	374
P	14	15	(20330000.)	374
S	15	16	(23240000.)	374
CL	16	17	(26340000.)	374
AR	17	18	29670000.	144
K	18	19	33110000.	144
CA	19	20	36760000.	144
SC	20	21	40650000.	144
TI	21	22	44840000.	144
V	22	23	49020000.	144
CR	23	24	53480000.	144
MN	24	25	58140000.	144
FE	25	26	62890000.	144
CO	26	27	68030000.	144
NI	27	28	73530000.	144
CU	28	29	78740000.	144
ZN	29	30	84750000.	144

TABLE I HELIUM ISOELECTRONIC SEQUENCE (cont.)

1S ( ) 3P 3P* 2

HE	1	2	185564.6540	497
LI	2	3	559501.42	307
BE	3	4	(1128000.)	374
B	4	5	(1892000.)	374
C	5	6	2851370.	262
N	6	7	4006120.	262
O	7	8	5356380.	487
F	8	9	6897570.	373
NE	9	10	*8640000.*	262
NA	10	11	(10580000.)	374
MG	11	12	(12710000.)	374
AL	12	13	(15060000.)	374
SI	13	14	(17600000.)	374
P	14	15	(20330000.)	374
S	15	16	(23240000.)	374
CL	16	17	(26340000.)	374
AR	17	18	29670000.	144
K	18	19	33110000.	144
CA	19	20	36760000.	144
SC	20	21	40650000.	144
TI	21	22	44840000.	144
V	22	23	49020000.	144
CR	23	24	53480000.	144
MN	24	25	58140000.	144
FE	25	26	62890000.	144
CO	26	27	68030000.	144
NI	27	28	73530000.	144
CU	28	29	78740000.	144
ZN	29	30	84750000.	144

1S ( ) 3P 1P* 1

HE	1	2	186209.471	497
LI	2	3	561752.82	307
BE	3	4	1132323.	487
B	4	5	1898180.	487
C	5	6	2859350.	487
N	6	7	4016390.	487
O	7	8	5368550.	487
F	8	9	6916590.	487
NE	9	10	8662500.	559
NA	10	11	10604000.	709
MG	11	12	12738400.	487
AL	12	13	15072700.	236
SI	13	14	(17620000.)	374
P	14	15	(20340000.)	374
S	15	16	(23250000.)	374
CL	16	17	(26350000.)	374
AR	17	18	29744200.	559
K	18	19	33110000.	144
CA	19	20	36760000.	144
SC	20	21	40650000.	144
TI	21	22	44840000.	144
V	22	23	49020000.	144
CR	23	24	53480000.	144
MN	24	25	58140000.	144
FE	25	26	62890000.	144
CO	26	27	68030000.	144
NI	27	28	73530000.	144
CU	28	29	78740000.	144
ZN	29	30	84750000.	144

TABLE I HELIUM ISOELECTRONIC SEQUENCE (cont.)

			1S ( ) 3D	3D 1
HE	1	2	186101.691	497
LI	2	3	561244.30	307
BE	3	4	(1131500.)	374
B	4	5	(1897000.)	374
C	5	6	2857308.	487
N	6	7	4013550.	262
O	7	8	5364990.	487
F	8	9	*6912360.*	487
NE	9	10	8657700.	559
NA	10	11	(10600000.)	374
MG	11	12	(12740000.)	374

			1S ( ) 3D	3D 2
HE	1	2	186101.646	497
LI	2	3	561243.15	307
BE	3	4	(1131500.)	374
B	4	5	(1897000.)	374
C	5	6	2857308.	487
N	6	7	4013550.	262
O	7	8	5364990.	487
F	8	9	6912360.	487
NE	9	10	8657700.	559
NA	10	11	(10600000.)	374
MG	11	12	(12740000.)	374

			1S ( ) 3D	3D 3
HE	1	2	186101.643	497
LI	2	3	561243.77	307
BE	3	4	(1131500.)	374
B	4	5	(1897000.)	374
C	5	6	2857308.	487
N	6	7	4013550.	262
O	7	8	5364990.	487
F	8	9	*6912360.*	487
NE	9	10	8657700.	559
NA	10	11	(10600000.)	374
MG	11	12	(12740000.)	374

			1S ( ) 3D	1D 2
HE	1	2	186105.065	497
LI	2	3	561273.62	307
BE	3	4	(1131500.)	374
B	4	5	(1897000.)	374
C	5	6	2857410.	262

TABLE I HELIUM ISOELECTRONIC SEQUENCE (cont.)

1S ( ) 4P 3P* 0

HE	1	2	191217.14	497
LI	2	3	581885.58	307
BE	3	4	(1178000.)	374
B	4	5	(1980000.)	374
C	5	6	2988400.	262
N	6	7	4202580.	262
O	7	8	5624000.	555
F	8	9	(7251000.)	374
NE	9	10	*9078400.*	262
NA	10	11	(11120000.)	374

1S ( ) 4P 3P* 1

HE	1	2	191217.14	497
LI	2	3	581885.98	307
BE	3	4	(1178000.)	374
B	4	5	(1980000.)	374
C	5	6	2988400.	262
N	6	7	4202580.	262
O	7	8	5624000.	555
F	8	9	(7251000.)	374
NE	9	10	*9078400.*	262
NA	10	11	(11120000.)	374

1S ( ) 4P 3P* 2

HE	1	2	191217.14	497
LI	2	3	581886.70	307
BE	3	4	(1178000.)	374
B	4	5	(1980000.)	374
C	5	6	2988400.	262
N	6	7	4202580.	262
O	7	8	5624000.	555
F	8	9	(7251000.)	374
NE	9	10	*9078400.*	262
NA	10	11	(11120000.)	374

1S ( ) 4P 1P* 1

HE	1	2	191492.817	497
LI	2	3	582830.11	307
BE	3	4	1179830.	487
B	4	5	1982750.	487
C	5	6	2991680.	487
N	6	7	4206810.	487
O	7	8	5628100.	487
F	8	9	7256680.	487
NE	9	10	9090100.	559
NA	10	11	(11132000.)	374
MG	11	12	13381100.	487
AL	12	13	15838600.	236
SI	13	14	(18504000.)	374
P	14	15	(21380000.)	374
S	15	16	(24465000.)	374
CL	16	17	(27761000.)	374
AR	17	18	31269500.	559
K	18	19	(34990000.)	374
CA	19	20	(38925000.)	374

TABLE I HELIUM ISOELECTRONIC SEQUENCE (cont.)

1S ( ) 5P 3P* 0

HE	1	2	193800.78	497
LI	2	3	592133.65	307
BE	3	4	(1201000.)	374
B	4	5	(2020000.)	374
C	5	6	3051350.	262
N	6	7	4293040.	262
O	7	8	5746490.	555
F	8	9	(7410000.)	374
NE	9	10	*9284000.*	262
NA	10	11	(11370000.)	374

1S ( ) 5P 3P* 1

HE	1	2	193800.78	497
LI	2	3	592134.03	307
BE	3	4	(1201000.)	374
B	4	5	(2020000.)	374
C	5	6	3051350.	262
N	6	7	4293040.	262
O	7	8	5746490.	555
F	8	9	(7410000.)	374
NE	9	10	*9284000.*	262
NA	10	11	(11370000.)	374

1S ( ) 5P 3P* 2

HE	1	2	193800.78	497
LI	2	3	592134.70	307
BE	3	4	(1201000.)	374
B	4	5	(2020000.)	374
C	5	6	3051350.	262
N	6	7	4293040.	262
O	7	8	5746490.	555
F	8	9	(7410000.)	374
NE	9	10	*9284000.*	262
NA	10	11	(11370000.)	374

1S ( ) 5P 1P* 1

HE	1	2	193942.57	497
LI	2	3	592634.91	307
BE	3	4	1201894.	487
B	4	5	2022000.	487
C	5	6	3053060.	487
N	6	7	(4294000.)	374
O	7	8	5748450.	487
F	8	9	7412900.	709
NE	9	10	9289400.	559
NA	10	11	(11380000.)	374
MG	11	12	13680600.	487
AL	12	13	(16190000.)	374
SI	13	14	(18910000.)	374
P	14	15	(21840000.)	374
S	15	16	(24980000.)	374
CL	16	17	(28325000.)	374
AR	17	18	31877600.	559
K	18	19	(35650000.)	374
CA	19	20	(39635000.)	374

TABLE II

TRANSITIONS - HELIUM ISOELECTRONIC SEQUENCE

		He I	Li II	Be III	B IV	C V	N VI	O VII	F VIII	Ne IX	Na X
$1s^2 - 2p$	$^1S_0 - {}^1P_1^o$	584.33	199.28	100.25	60.31	40.27	28.79	21.60	16.81	13.45	11.00
$1s^2 - 3p$	$^1S_0 - {}^1P_1^o$	537.03	178.01	88.31	52.68	34.97	24.90	18.63	14.46	11.54	9.43
$1s^2 - 4p$	$^1S_0 - {}^1P_1^o$	522.21	171.58	84.76	50.44	33.43	23.77	17.77	13.78	11.00	(8.98)
$1s^2 - 5p$	$^1S_0 - {}^1P_1^o$	515.62	168.74	83.20	49.46	32.75	23.29	17.40	13.49	10.76	(8.79)
$2s - 2p$	$^3S_1 - {}^3P_2^o$	10833.30	5485.93	3722.04	2822.55	2271.59	1896.81	1623.38	1421.67	1180.64	(1060.45)
$2s - 3p$	$^3S_1 - {}^3P_2^o$	3889.75	1198.09	(583.08)	(344.24)	(227.22)	161.22	120.23	93.66	74.40	(60.64)
	$^1S_0 - {}^1P_1^o$	5017.08	1420.89	(661.28)	(380.69)	(247.01)	(173.04)	(127.87)	98.34	(77.82)	
$2s - 4p$	$^3S_1 - {}^3P_2^o$	3188.67	944.72	(451.46)	(264.20)	173.27	122.44	91.02	(70.37)	56.10	(45.68)
	$^1S_0 - {}^1P_1^o$	3965.85	1093.43	(503.20)	(287.98)	(186.16)	(130.15)	(96.01)	73.69	(58.39)	
$2s - 5p$	$^3S_1 - {}^3P_2^o$	2945.97	861.33	(408.99)	(238.95)	156.23	110.23	81.89	(63.29)	50.30	(41.00)
	$^1S_0 - {}^1P_1^o$	3614.67	987.55	(452.91)	(258.73)	(167.07)	(116.89)	(86.06)	66.09	(52.30)	
$2p - 3d$	$^3P_2^o - {}^3D_3$	5877.24	1452.98	(675.05)	(384.52)	248.74	173.92	128.53	98.80	78.30	(63.50)
	$^1P_1^o - {}^1D_2$	6680.00	1681.66	(746.08)	(418.45)	267.26					
$2p - 3s$	$^3P_2^o - {}^3S_1$	7067.12	1653.14	(723.92)	(407.22)	(260.61)	(181.02)	133.31	(102.22)	(81.01)	

Note: Transitions in Angstroms

( ) indicates prediction.

TABLE II

TRANSITIONS - HELIUM ISOELECTRONIC SEQUENCE (continued)

		Mg XI	Al XII	Si XIII	P XIV	S XV	Cl XVI	Ar XVII	K XVIII	Ca XIX	Sc XX
$1s^2$ - 2p	$^1S_0$ - $^1P_1^o$	9.17	7.76	(6.65)	(5.76)	(5.04)	(4.45)	3.94	3.54	3.19	2.88
$1s^2$ - 3p	$^1S_0$ - $^1P_1^o$	7.85	6.63	(5.68)	(4.92)	(4.30)	(3.79)	3.36	3.02	2.72	2.46
$1s^2$ - 4p	$^1S_0$ - $^1P_1^o$	7.47	6.31	(5.40)	(4.68)	(4.09)	(3.60)	3.20	(2.86)	(2.57)	
$1s^2$ - 5p	$^1S_0$ - $^1P_1^o$	7.31	(6.18)	(5.29)	(4.58)	(4.00)	(3.53)	3.14	(2.80)	(2.52)	
2s - 2p	$^3S_1$ - $^3P_2^o$	(950.57)	(847.46)	(763.36)							
2s - 3p	$^3S_1$ - $^3P_2^o$	(50.48)	(42.23)	(35.96)							
	$^1S_0$ - $^1P_1^o$										
2s - 4p	$^3S_1$ - $^3P_2^o$										
	$^1S_0$ - $^1P_1^o$										
2s - 5p	$^3S_1$ - $^3P_2^o$										
	$^1S_0$ - $^1P_1^o$										
2p - 3d	$^3P_2^o$ - $^3D_3$	(52.47)									
	$^1P_1^o$ - $^1D_2$										
2p - 3s	$^3P_2^o$ - $^3S_1$										

TABLE III LITHIUM ISOELECTRONIC SEQUENCE

1S2			( ) 3S	2S 1
LI	1	3	27206.12	487
BE	2	4	88231.91	332
B	3	5	180201.8	487
C	4	6	302847.9	487
N	5	7	456129.7	313
O	6	8	640039.8	487
F	7	9	854625.	487
NE	8	10	1100000.	255
NA	9	11	1375944.	487
MG	10	12	1682648.	487
AL	11	13	2020460.	487
SI	12	14	2390580.	487
P	13	15	2794900.	487
S	14	16	(3223000.)	374
CL	15	17	(3685000.)	374
AR	16	18	(4178000.)	374
K	17	19	(4701000.)	374
CA	18	20	(5257000.)	374

1S2			( ) 3P	2P* 1
LI	1	3	30925.38	487
BE	2	4	96495.36	332
B	3	5	192949.2	487
C	4	6	320048.5	487
N	5	7	477766.3	313
O	6	8	666113.2	487
F	7	9	885136.	487
NE	8	10	1134900.	255
NA	9	11	1415368.	487
MG	10	12	1726519.	487
AL	11	13	2068770.	487
SI	12	14	2442000.	774
P	13	15	2844390.	487
S	14	16	(3279000.)	374
CL	15	17	(3743000.)	374
AR	16	18	(4239000.)	374
K	17	19	(4765000.)	374
CA	18	20	(5322000.)	374

1S2			( ) 3P	2P* 2
LI	1	3	30925.38	487
BE	2	4	96497.28	332
B	3	5	192959.4	487
C	4	6	320080.0	487
N	5	7	477843.2	313
O	6	8	666269.8	487
F	7	9	885418.	487
NE	8	10	1134900.	255
NA	9	11	1416130.	487
MG	10	12	1727832.	487
AL	11	13	2070520.	487
SI	12	14	2444390.	774
P	13	15	2850150.	487
S	14	16	(3284000.)	374
CL	15	17	(3750000.)	374
AR	16	18	(4247000.)	374
K	17	19	(4775000.)	374
CA	18	20	(5333000.)	374

TABLE III LITHIUM ISOELECTRONIC SEQUENCE (cont.)

1S2 ( ) 3D 2D 2

LI	1	3	31283.08	487
BE	2	4	98054.57	332
B	3	5	196068.1	168
C	4	6	324880.2	487
N	5	7	484404.0	313
O	6	8	674625.7	487
F	7	9	895632.	487
NE	8	10	1147400.	255
NA	9	11	1429980.	487
MG	10	12	1743410.	487
AL	11	13	2087980.	487
SI	12	14	2463540.	487
P	13	15	2870260.	487
S	14	16	(3308900.)	375
CL	15	17	(3777100.)	375
AR	16	18	(4280400.)	374
K	17	19	(4814500.)	374
CA	18	20	(5381000.)	374

1S2 ( ) 3D 2D 3

LI	1	3	31283.12	487
BE	2	4	98055.12	332
B	3	5	196071.2	487
C	4	6	324890.9	487
N	5	7	484426.5	313
O	6	8	674676.8	487
F	7	9	895722.	487
NE	8	10	1147400.	255
NE	8	10	1147600.	374
NA	9	11	1430204.	487
MG	10	12	1743880.	487
AL	11	13	2088540.	487
SI	12	14	2464530.	487
P	13	15	2871620.	487
S	14	16	(3314000.)	375
CL	15	17	(3777700.)	375
AR	16	18	(4284000.)	374
K	17	19	(4819200.)	374
CA	18	20	(5387100.)	374

1S2 ( ) 4S 2S 1

LI	1	3	35012.06	487
BE	2	4	115464.40	332
B	3	5	237695.5	487
C	4	6	401346.7	487
N	5	7	606347.7	313
O	6	8	852696.	487
F	7	9	1140416.	487
NE	8	10	1469600.	255
NA	9	11	1840336.	487
MG	10	12	(2253000.)	374
AL	11	13	(2707800.)	374
SI	12	14	(3205000.)	374
P	13	15	(3745300.)	374
S	14	16	(4329000.)	374
CL	15	17	(4956800.)	374
AR	16	18	(5629300.)	374
K	17	19	(6347300.)	374
CA	18	20	(7111500.)	374

TABLE IV

TRANSITIONS - LITHIUM ISOELECTRONIC SEQUENCE

		Li I	Be II	B III	C IV	N V	O VI	F VII	Ne VIII	Na IX
2s - 3p	${}^2S_{1/2} - {}^2P^o_{1/2}$	3233.59	1036.32	518.27	312.45	209.31	150.12	112.98	88.11	70.65
	${}^2S_{1/2} - {}^2P^o_{3/2}$	3233.59	1036.29	518.24	312.42	209.27	150.09	112.94	88.11	70.62
2p - 3s	${}^2P^o_{1/2} - {}^2S_{1/2}$	8128.46	1776.10	758.48	419.53	266.19	183.94	134.70	102.90	81.18
	${}^2P^o_{3/2} - {}^2S_{1/2}$	8128.68	1776.31	758.67	419.72	266.38	184.12	134.88	103.07	81.35
2p - 4s	${}^2P^o_{1/2} - {}^2S_{1/2}$	4973.05	1197.09	528.16	296.86	190.15	132.22	97.26	74.55	58.95
	${}^2P^o_{3/2} - {}^2S_{1/2}$	4973.13	1197.19	528.26	296.95	190.25	132.31	97.35	74.64	59.04
2p - 3d	${}^2P^o_{1/2} - {}^2D_{3/2}$	6105.22	1512.26	677.00	384.03	247.56	172.94	127.65	98.11	77.76
	${}^2P^o_{3/2} - {}^2D_{5/2}$	6105.33	1512.41	677.15	384.17	247.71	173.08	127.80	(98.25)	77.91

		Mg X	Al XI	Si XII	P XIII	S XIV	Cl XV	Ar XVI	K XVII	Ca XVIII
2s - 3p	${}^2S_{1/2} - {}^2P^o_{1/2}$	57.92	48.34	40.95	35.16	(30.50)	(26.72)	(23.59)	(20.99)	(18.79)
	${}^2S_{1/2} - {}^2P^o_{3/2}$	57.88	48.30	40.91	35.09	(30.45)	(26.67)	(23.55)	(20.94)	(18.75)
2p - 3s	${}^2P^o_{1/2} - {}^2S_{1/2}$	65.67	54.21	45.48	38.65	(33.35)	(29.04)	(25.51)	(22.59)	(20.14)
	${}^2P^o_{3/2} - {}^2S_{1/2}$	65.84	54.39	45.66	38.83	(33.52)	(29.21)	(25.68)	(22.77)	(20.32)
2p - 4s	${}^2P^o_{1/2} - {}^2S_{1/2}$	(47.78)	(39.50)	(33.19)	(28.27)	(24.36)	(21.21)	(18.62)	(16.47)	(14.67)
	${}^2P^o_{3/2} - {}^2S_{1/2}$	(47.87)	(39.59)	(33.28)	(28.36)	(24.46)	(21.30)	(18.71)	(16.56)	(14.76)
2p - 3d	${}^2P^o_{1/2} - {}^2D_{3/2}$	63.15	52.30	44.02	37.56	(32.42)	(28.28)	(24.86)	(22.03)	(19.65)
	${}^2P^o_{3/2} - {}^2D_{5/2}$	63.30	52.45	44.16	37.70	(32.53)	(28.43)	(25.00)	(22.17)	(19.79)

Note: Transitions in Angstroms. ( ) indicates prediction.

TABLE V BERYLLIUM ISOELECTRONIC SEQUENCE

1S2 2S ( ) 2P 3P* 0

BE	1	4	21978.28	333
B	2	5	*37333.6*	487
C	3	6	52367.06	034
N	4	7	67209.2	824
O	5	8	81939.2	083
F	6	9	96601.	487
NE	7	10	*111251.*	071
NA	8	11	*125913.*	487
MG	9	12	*140528.*	487
AL	10	13	*154850.*	487
SI	11	14	*169140.*	487
P	12	15	*183190.*	487
S	13	16	(198000.)	374
CL	14	17	(212000.)	374
AR	15	18	(226000.)	374

1S2 2S ( ) 2P 3P* 1

BE	1	4	21978.92	333
B	2	5	*37340.*	487
C	3	6	52390.75	034
N	4	7	67272.3	824
O	5	8	82075.3	083
F	6	9	96867.	209
NE	7	10	*111706.*	071
NA	8	11	*126643.*	487
MG	9	12	*141690.*	209
AL	10	13	*156540.*	487
SI	11	14	*171560.*	487
P	12	15	*186390.*	487
S	13	16	(202000.)	374
CL	14	17	(217000.)	374
CL	14	17	250000.	269
AR	15	18	(232000.)	374

1S2 2S ( ) 2P 3P* 2

BE	1	4	21981.27	333
B	2	5	*37356.4*	487
C	3	6	52447.11	034
N	4	7	67416.3	824
O	5	8	82382.0	083
F	6	9	97437.	487
NE	7	10	*112700.*	071
NA	8	11	*128247.*	487
MG	9	12	*144162.*	487
AL	10	13	*160200.*	487
SI	11	14	*176810.*	487
P	12	15	*192990.*	487
S	13	16	(210000.)	374
CL	14	17	(227000.)	374
CL	14	17	250000.	269
AR	15	18	(244000.)	374

TABLE V BERYLLIUM ISOELECTRONIC SEQUENCE (cont.)

1S2 2S ( ) 2P 1P* 1

BE	1	4	42565.35	333
B	2	5	73396.7	487
C	3	6	102352.04	034
N	4	7	130693.9	824
O	5	8	158797.7	083
F	6	9	186841.	487
NE	7	10	214952.	071
NA	8	11	243223.	487
MG	9	12	271687.	487
AL	10	13	300400.	487
SI	11	14	329700.	827
P	12	15	358840.	487
S	13	16	(387000.)	374
CL	14	17	(415000.)	374
CL	14	17	*400000.*	269
AR	15	18	(444000.)	374

1S2 2S ( ) 3S 3S 1

BE	1	4	52080.94	333
B	2	5	*129772.9*	487
C	3	6	238213.00	034
N	4	7	377284.8	824
O	5	8	546969.4	083
F	6	9	747298.	487
NE	7	10	*978300.0*	071
NA	8	11	*1240115.*	487
MG	9	12	*1532491.*	487
AL	10	13	*1855510.*	487
SI	11	14	(2209000.)	374
P	12	15	*2594640.*	487
S	13	16	(3008000.)	374
CL	14	17	(3453000.)	374
AR	15	18	(3929000.)	374

1S2 2S ( ) 3S 1S 0

BE	1	4	54677.26	333
B	2	5	135946.	487
C	3	6	247170.26	034
N	4	7	388854.6	824
O	5	8	561276.4	083
F	6	9	764392.	487
NE	7	10	998400.	255
NA	8	11	1262799.	487
MG	9	12	1558076.	487
AL	10	13	1884330.	487
SI	11	14	2241480.	487
P	12	15	2629250.	487
S	13	16	(3047000.)	374
CL	14	17	(3495000.)	374
AR	15	18	(3975000.)	374

TABLE V BERYLLIUM ISOELECTRONIC SEQUENCE (cont.)

1S2 2S ( ) 3P 3P* 0

BE	1	4	58907.47	333
B	2	5	*143989.7*	487
C	3	6	259705.55	034
N	4	7	405971.6	824
O	5	8	582803.1	083
F	6	9	790253.	KA60
NE	7	10	*1028366.5*	071
NA	8	11	(1297400.)	374
MG	9	12	(1597400.)	374
AL	10	13	(1928600.)	374

1S2 2S ( ) 3P 3P* 1

BE	1	4	58907.47	333
B	2	5	*143989.7*	487
C	3	6	259711.22	034
N	4	7	405987.5	824
O	5	8	582839.8	083
F	6	9	790326.	487
NE	7	10	*1028499.3*	071
NA	8	11	(1297600.)	374
MG	9	12	(1597700.)	374
AL	10	13	(1929000.)	374

1S2 2S ( ) 3P 3P* 2

BE	1	4	58907.84	333
B	2	5	*143993.4*	487
C	3	6	259724.30	034
N	4	7	406022.8	824
O	5	8	582917.0	083
F	6	9	790474.	487
NE	7	10	*1028754.7*	071
NA	8	11	(1298000.)	374
MG	9	12	(1598400.)	374
AL	10	13	(1930000.)	374

1S2 2S ( ) 3P 1P* 1

BE	1	4	60187.36	333
B	2	5	144102.0	487
C	3	6	258931.29	034
N	4	7	404522.4	824
O	5	8	580824.9	083
F	6	9	787833.	487
NE	7	10	1025200.	255
NA	8	11	1294214.	487
MG	9	12	1593600.	487
AL	10	13	1923850.	487
SI	11	14	2285040.	487
P	12	15	2677740.	487
S	13	16	(3101500.)	374
CL	14	17	(3556700.)	374
AR	15	18	(4043600.)	374
K	16	19	(4562300.)	374

TABLE V BERYLLIUM ISOELECTRONIC SEQUENCE (cont.)

1S2 2S ( ) 3D 3D 1

BE	1	4	62053.72	333
B	2	5	*150649.0*	487
C	3	6	270010.83	034
N	4	7	420045.8	824
O	5	8	600745.6	083
F	6	9	812169.	487
NE	7	10	(1054370.)	375
NA	8	11	*1327259.*	487
MG	9	12	*1631063.*	487
AL	10	13	*1965560.*	487
SI	11	14	*2330650.*	487
P	12	15	*2726690.*	487
S	13	16	(3150500.)	374
CL	14	17	(3608000.)	374
AR	15	18	(4096000.)	374

1S2 2S ( ) 3D 3D 2

BE	1	4	62053.72	333
B	2	5	*150649.0*	487
C	3	6	270011.93	034
N	4	7	420049.6	824
O	5	8	600755.6	083
F	6	9	812169.	487
NE	7	10	1054410.	255
NA	8	11	*1327296.*	487
MG	9	12	*1631226.*	487
AL	10	13	*1965770.*	487
SI	11	14	*2331160.*	487
P	12	15	*2727190.*	487
S	13	16	*3152500.*	269
CL	14	17	(3609000.)	374
CL	14	17	*3645600.*	269
AR	15	18	(4097000.)	374

1S2 2S ( ) 3D 3D 3

BE	1	4	62053.72	333
B	2	5	*150649.0*	487
C	3	6	271014.74	034
N	4	7	420058.0	824
O	5	8	600775.9	083
F	6	9	812208.	487
NE	7	10	1054480.	255
NA	8	11	*1327417.*	487
MG	9	12	*1631394.*	487
AL	10	13	*1966050.*	487
SI	11	14	*2331940.*	487
P	12	15	*2727840.*	487
S	13	16	*3152500.*	269
CL	14	17	(3606000.)	374
CL	14	17	*3638700.*	269
AR	15	18	(4093000.)	374

TABLE V BERYLLIUM ISOELECTRONIC SEQUENCE (cont.)

1S2 2S ( ) 3D 1D 2

BE	1	4	64428.31	333
B	2	5	154686.9	487
C	3	6	276482.86	034
N	4	7	429159.6	824
O	5	8	612615.6	083
F	6	9	826853.	487
NE	7	10	1072200.	255
NA	8	11	1347756.	487
MG	9	12	1654583.	487
AL	10	13	1992250.	487
SI	11	14	2361310.	827
P	12	15	2760490.	487
S	13	16	(3191000.)	374
CL	14	17	*3634200.*	269
CL	14	17	(3653000.)	374
AR	15	18	(4146000.)	374

1S2 2S ( ) 4S 3S 1

BE	1	4	64506.43	333
B	2	5	*166344.4*	487
C	3	6	309457.17	034
N	4	7	498045.5	824
O	5	8	722476.7	083
F	6	9	989928.	487
NE	7	10	1298400.	255
NA	8	11	*1649542.*	487
MG	9	12	(2040000.)	374
AL	10	13	(2473000.)	374

1S2 2S ( ) 4S 1S 0

BE	1	4	65245.34	333
B	2	5	167934.2	487
C	3	6	311721.51	034
N	4	7	(501800.)	374
O	5	8	731670.5	083
F	6	9	997693.	487
NE	7	10	(1306500.)	374
NA	8	11	1656830.	487
MG	9	12	(2052500.)	374
AL	10	13	(2498600.)	374

1S2 2S ( ) 4P 1P* 1

BE	1	4	67034.70	333
B	2	5	(174800.)	374
C	3	6	322404.20	034
N	4	7	507027.9	824
O	5	8	737880.8	083
F	6	9	1007852.	487
NE	7	10	1319600.	255
NA	8	11	1673388.	487
MG	9	12	2068680.	487
AL	10	13	(2504000.)	374
SI	11	14	2982000.	776

1S2 2S ( ) 5P 1P* 1

BE	1	4	70120.49	333
B	2	5	(182100.)	374
C	3	6	343258.03	034
N	4	7	550232.6	824
O	5	8	802466.	083
F	6	9	1099409.	487
NE	7	10	(1443800.)	374
NA	8	11	1838911.	487
MG	9	12	(2290200.)	374
AL	10	13	(2804700.)	374

1S2 2P (2P*) 3S 3P* 0

BE	1	4	85553.8	333
B	2	5	*181645.2 *	487
C	3	6	308216.58	034
N	4	7	465291.8	824
O	5	8	652914.7	083
F	6	9	871160.	487
NE	7	10	(1120100.)	374
NA	8	11	*1399718.*	487
MG	9	12	*1710220.*	487
AL	10	13	(2052000.)	374

1S2 2P (2P*) 3S 3P* 1

BE	1	4	85556.11	333
B	2	5	*181655.0*	487
C	3	6	308248.91	034
N	4	7	465371.0	824
O	5	8	653076.8	083
F	6	9	871441.	487
NE	7	10	(1120500.)	374
NA	8	11	*1400523.*	487
MG	9	12	*1711314.*	487
AL	10	13	(2055000.)	374

1S2 2P (2P*) 3S 3P* 2

BE	1	4	85560.11	333
B	2	5	*181675.9*	487
C	3	6	308317.29	034
N	4	7	465536.6	824
O	5	8	653420.0	083
F	6	9	872078.	487
NE	7	10	1121800.	255
NA	8	11	*1402237.*	487
MG	9	12	*1713847.*	487
AL	10	13	*2056910.*	487

TABLE V BERYLLIUM ISOELECTRONIC SEQUENCE (cont.)

1S2			2P (2P*) 3S	1P* 1
BE	1	4	(82000.)	374
B	2	5	(181000.)	374
C	3	6	310006.32	034
N	4	7	473029.3	824
O	5	8	664485.9	083
F	6	9	884290.	487
NE	7	10	1131700.	255
NA	8	11	1426049.	487
MG	9	12	1742772.	487
AL	10	13	2090980.	487
SI	11	14	(2470000.)	374
P	12	15	2876720.	487
S	13	16	(3310000.)	374

1S2			2P (2P*) 3P	3S 1
BE	1	4	(96000.)	374
B	2	5	(196000.)	374
C	3	6	327278.27	034
N	4	7	487607.4	824
O	5	8	683939.6	083
F	6	9	909284.	171
NE	7	10	1165400.	255
NA	8	11	*1452428.*	487
MG	9	12	*1770430.*	487
AL	10	13	*2119440.*	487
SI	11	14	(2500000.)	374

1S2			2P (2P*) 3P	1S 0
BE	1	4	(106000.)	374
B	2	5	(210000.)	374
C	3	6	345095.43	034
N	4	7	(511000.)	374
O	5	8	707635.5	083
F	6	9	934633.	487
NE	7	10	(1193000.)	374
NA	8	11	1481521.	487

1S2			2P (2P*) 3P	3P 0
BE	1	4	92014.82	333
B	2	5	(195600.)	374
C	3	6	329685.38	034
N	4	7	494253.1	824
O	5	8	689400.2	083
F	6	9	915196.	487
NE	7	10	(1171500.)	374
NA	8	11	(1458000.)	374
MG	9	12	*1777628.*	487
AL	10	13	(2124000.)	374

TABLE V BERYLLIUM ISOELECTRONIC SEQUENCE (cont.)

1S2 2P (2P*) 3P 3P 1

BE	1	4	92015.97	333
B	2	5	(195600.)	374
C	3	6	329706.47	034
N	4	7	494309.2	824
O	5	8	689514.4	083
F	6	9	915420.	487
NE	7	10	(1172000.)	374
NA	8	11	*1460104.*	487
MG	9	12	*1778745.*	487
AL	10	13	*2128300.*	487

1S2 2P (2P*) 3P 3P 2

BE	1	4	92018.10	333
B	2	5	(195600.)	374
C	3	6	329743.57	034
N	4	7	494402.0	824
O	5	8	689705.2	083
F	6	9	915770.	487
NE	7	10	1172800.	255
NA	8	11	*1460988.*	487
MG	9	12	*1780057.*	487
AL	10	13	*2130180.*	487

1S2 2P (2P*) 3P 1P 1

BE	1	4	(89300.)	374
B	2	5	189126.6	487
C	3	6	319720.35	034
N	4	7	480884.2	824
O	5	8	672693.8	083
F	6	9	895287.	487
NE	7	10	1149000.	255
NA	8	11	1432991.	487
MG	9	12	1748116.	487
AL	10	13	2094730.	487
SI	11	14	(2473000.)	374
P	12	15	2888690.	487

1S2 2P (2P*) 3P 3D 1

BE	1	4	(92800.)	374
B	2	5	(192400.)	374
C	3	6	323076.88	034
N	4	7	484498.2	824
O	5	8	677147.4	083
F	6	9	900442.	487
NE	7	10	(1155000.)	374
NA	8	11	*1439444.*	487
MG	9	12	*1755785.*	487
AL	10	13	*2101950.*	487
SI	11	14	(2482970.)	375

1S2			2P (2P*) 3P 3D 2	
BE	1	4	(92800.)	374
B	2	5	(192400.)	374
C	3	6	323101.36	034
N	4	7	484594.9	824
O	5	8	677345.2	083
F	6	9	900785.	487
NE	7	10	(1155500.)	374
NA	8	11	*1440290.*	487
MG	9	12	*1756545.*	487
AL	10	13	*2103560.*	487
SI	11	14	(2484510.)	375

1S2			2P (2P*) 3P 3D 3	
BE	1	4	(92800.)	374
B	2	5	(192400.)	374
C	3	6	323140.33	034
N	4	7	484746.2	824
O	5	8	677661.7	083
F	6	9	901397.	487
NE	7	10	1155900.	255
NA	8	11	*1441910.*	487
MG	9	12	*1759045.*	487
AL	10	13	*2107290.*	487
SI	11	14	*2486810.*	487
P	12	15	*2897300.*	487

1S2			2P (2P*) 3P 1D 2	
BE	1	4	(94800.)	374
B	2	5	(198600.)	374
C	3	6	333118.21	034
N	4	7	499705.9	824
O	5	8	697170.2	083
F	6	9	925393.	487
NE	7	10	(1184000.)	374
NA	8	11	1474598.	487
MG	9	12	1795868.	487
AL	10	13	2148320.	487
SI	11	14	2532140.	487
P	12	15	2947770.	487
S	13	16	(3395000.)	374
CL	14	17	(3875000.)	374
AR	15	18	(4387000.)	374

TABLE V BERYLLIUM ISOELECTRONIC SEQUENCE (cont.)

1S2 2P2( ) 1D 2

BE	1	4	56882.42	333
B	2	5	102362.1	487
C	3	6	145876.13	034
N	4	7	188882.5	824
O	5	8	231721.4	083
F	6	9	274597.	487
NE	7	10	*300000.*	255
NE	7	10	317500.	374
NA	8	11	361046.	487
MG	9	12	404744.	487
AL	10	13	448840.	487
SI	11	14	*493400.*	487
P	12	15	538190.	487
S	13	16	(582600.)	374
CL	14	17	(626500.)	374
AR	15	18	(669300.)	374

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TABLE VI

TRANSITIONS - BERYLLIUM ISOELECTRONIC SEQUENCE

		Be I	B II	C III	N IV	O V	F VI	Ne VII	Na VIII
$2s^2$ - 2s2p	$^1S_0 - {}^1P^0_1$	2349.33	1362.46	977.02	765.15	629.73	535.21	465.22	411.15
2s2p - 2s3s	$^1P^0_1 - {}^1S_0$	8256.34	1598.74	690.52	387.36	248.46	173.14	127.64	98.08
2s2p - 2s3d	$^3P^0_2 - {}^3D_3$	2495.48	882.67	491.16	283.57	192.90	139.90	106.18	83.39
	$^1P^0_1 - {}^1D_2$	4573.95	1230.16	574.28	335.05	220.35	156.25	116.65	90.54
2s2p - 2s4s	$^3P^0_2 - {}^3S_1$	2351.55	775.27	389.09	232.22	156.23	112.05	84.84	65.73
	$^1P^0_1 - {}^1S_0$	4409.17	1057.78	477.62	(269.46)	174.56	123.33	(91.61)	70.74
2s2p - 2p3p	$^3P^0_2 - {}^3S_1$	(1351.01)	(630.34)	363.86	237.99	166.24	123.18	94.99	75.51
	$^3P^0_2 - {}^3P_2$	1427.82	(631.94)	360.63	234.20	164.66	122.20	94.33	75.03
	$^3P^0_2 - {}^3D_3$	(1412.06)	(644.98)	369.42	239.62	167.99	124.38	95.86	76.12
	$^1P^0_1 - {}^1S_0$	(1576.42)	(732.05)	411.96	262.95	182.20	133.73	(102.24)	80.76
	$^1P^0_1 - {}^1D_2$	(1914.44)	(798.70)	433.34	270.99	185.74	135.40	(103.19)	81.21
2s2p - $2p^2$	$^1P^0_1 - {}^1D_2$	6984.67	3452.39	2297.53	1718.55	1371.30	1139.52	(975.15)	848.73
2s3s - 2s3p	$^1S_0 - {}^1P^0_1$	18148.49	12260.91	8502.66	6382.52	5115.72	4266.03	3731.34	3183.19
2s3s - 2s4p	$^1S_0 - {}^1P^0_1$	8092.29	2573.74	1329.19	846.21	566.24	410.75	311.33	243.55
2s3s - 2s5p	$^1S_0 - {}^1P^0_1$	6475.33	(2166.66)	1040.72	619.66	414.61	298.49	(224.52)	173.58
2s3s - 2p3s	$^1S_0 - {}^1P^0_1$	(3659.56)	(2219.55)	1591.44	1188.01	968.90	834.04	750.19	612.56

Note: Transitions in Angstroms. (   ) indicates prediction.

TABLE VI

TRANSITIONS - BERYLLIUM ISOELECTRONIC SEQUENCE (continued)

		Mg IX	Al X	Si XI	P XII	S XIII	Cl XIV	Ar XV
$2s^2$ - 2s2p	$^1S_0$ - $^1P^0_1$	368.07	332.89	303.31	278.68	(258.40)	(240.96)	(225.23)
2s2p - 2s3s	$^1P^0_1$ - $^1S_0$	77.74	63.13	52.31	44.04	(37.59)	(32.47)	(28.32)
2s2p - 2s3d	$^3P^0_2$ - $^3D_3$	67.24	55.38	46.40	39.45	(34.01)	(29.60)	(25.98)
	$^1P^0_1$ - $^1D_2$	72.31	59.11	49.22	41.64	(35.66)	(30.88)	(27.01)
2s2p - 2s4s	$^3P^0_2$ - $^3S_1$	(52.50)	(42.70)					
	$^1P^0_1$ - $^1S_0$	(56.15)	(45.49)					
2s2p - 2p3p	$^3P^0_2$ - $^3S_1$	61.49	51.04	(43.04)				
	$^3P^0_2$ - $^3P_2$	61.13	50.76					
	$^3P^0_2$ - $^3D_3$	61.92	51.36	43.29	36.98			
	$^1P^0_1$ - $^1S_0$							
	$^1P^0_1$ - $^1D_2$	65.61	54.11	45.40	38.62	(33.24)	(28.90)	(25.36)
2s2p - $2p^2$	$^1P^0_1$ - $^1D_2$	751.56	673.67	610.87	557.57	(511.25)	(472.81)	(443.85)
2s3s - 2s3p	$^1S_0$ - $^1P^0_1$	2815.00	2530.36	2295.68	2062.28	(1834.86)	(1629.75)	(1457.73)
2s3s - 2s4p	$^1S_0$ - $^1P^0_1$	195.85	(161.38)	(135.22)				
2s3s - 2s5p	$^1S_0$ - $^1P^0_1$	(136.59)	(108.65)					
2s3s - 2p3s	$^1S_0$ - $^1P^0_1$	541.43	483.91	(383.14)	404.09	(331.12)		

TABLE VII   BORON ISOELECTRONIC SEQUENCE

1S2   2S2(   ) 2PG 2P* 2

B	1	5	15.15	62
C	02	06	64.00	287
N	3	7	174.5	487
O	4	8	385.9	086
F	5	9	746.	487
NE	6	10	1310.	071
NA	7	11	2139.	487
MG	8	12	3304.	487
AL	9	13	4890.	487
SI	10	14	6990.	487
P	11	15	9700.	487
S	12	16	(13130.)	374
CL	13	17	*20000.*	269
CL	13	17	(17400.)	374
AR	14	18	(22630.)	374
K	15	19	(28970.)	374
CA	16	20	(36550.)	374

1S2   2S2(   ) 3S 2S 1

B	1	5	40039.52	62
C	02	06	116538.08	287
N	3	7	221302.4	487
O	4	8	357614.3	086
F	5	9	524751.	487
NE	6	10	722610.	487
NA	7	11	951347.	487
MG	8	12	1210689.	487
AL	9	13	1501020.	487
SI	10	14	(1822000.)	374
P	11	15	2174060.	487
S	12	16	(2556000.)	374
CL	13	17	(2970000.)	374
AR	14	18	(3414000.)	374

1S2   2S2(   ) 3P 2P* 1

B	1	5	48611.69	62
C	02	06	131724.80	287
N	3	7	245665.7	487
O	4	8	390161.2	086
F	5	9	565367.	487
NE	6	10	*771234.1*	071
NA	7	11	(1078000.)	374
MG	8	12	(1275000.)	374
AL	9	13	(1573000.)	374

TABLE VII BORON ISOELECTRONIC SEQUENCE (cont.)

1S2 2S2( ) 3P 2P* 2

B	1	5	48613.47	62
C	02	06	131735.95	287
N	3	7	245701.7	487
O	4	8	390248.0	086
F	5	9	565544.	487
NE	6	10	*771556.7*	071
NA	7	11	1008418.	487
MG	8	12	(1276000.)	374
AL	9	13	(1575000.)	374

1S2 2S2( ) 4S 2S 1

B	1	5	55010.08	62
C	02	06	157234.50	287
N	3	7	301088.2	487
O	4	8	485821.7	086
F	5	9	712936.	487
NE	6	10	(983000.)	374
NA	7	11	1294914.	487
MG	8	12	1647879.	487
AL	9	13	(2043000.)	374
SI	10	14	(2481000.)	374

1S2 2S2( ) 5S 2S 1

B	1	5	60146.24	62
C	02	06	173348.27	287
N	3	7	333713.1	487
O	4	8	539368.	086
F	5	9	(791500.)	374
NE	6	10	(1090000.)	374

1S2 2S 2P2( ) 2S 1

B	1	5	63561.	487
C	02	06	96494.17	287
N	3	7	131003.5	487
O	4	8	164366.4	086
F	5	9	197565.	487
NE	6	10	230853.	071
NA	7	11	264400.	487
MG	8	12	298283.	487
AL	9	13	332650.	487
SI	10	14	367650.	487
P	11	15	403330.	487
S	12	16	(440500.)	374
CL	13	17	(479000.)	374
AR	14	18	(519500.)	374

TABLE VII BORON ISOELECTRONIC SEQUENCE (cont.)

1S2 2S 2P2( ) 2P 1

B	1	5	72535.	487
C	02	06	110624.60	287
N	3	7	145876.1	487
O	4	8	180480.8	086
F	5	9	214881.	487
NE	6	10	249292.	487
NA	7	11	283869.	487
MG	8	12	318747.	487
AL	9	13	353960.	487
SI	10	14	389740.	487
P	11	15	425820.	487
S	12	16	(460000.)	374
CL	13	17	(495000.)	374
AR	14	18	(530000.)	374

1S2 2S 2P2( ) 2P 2

B	1	5	72547.	487
C	02	06	110665.99	287
N	3	7	145986.5	487
O	4	8	180724.2	086
F	5	9	215348.	487
NE	6	10	250112.	487
NA	7	11	285189.	487
MG	8	12	320742.	487
AL	9	13	356950.	487
SI	10	14	394000.	487
P	11	15	431650.	487
S	12	16	(467000.)	374
CL	13	17	(504000.)	374
AR	14	18	(540000.)	374

1S2 2P3( ) 2P* 1

B	1	5	(111100.)	374
C	02	06	168729.96	287
N	3	7	230404.5	487
O	4	8	289015.4	086
F	5	9	347418.	487
NE	6	10	*405984.*	071
NA	7	11	465017.	487
MG	8	12	524339.	487
AL	9	13	584150.	487
SI	10	14	644560.	487
P	11	15	(703300.)	374
S	12	16	(762800.)	374
CL	13	17	(822000.)	374

TABLE VII BORON ISOELECTRONIC SEQUENCE (cont.)

1S2			2P3( )	2P* 2
B	1	5	(111200.)	374
C	02	06	168748.73	287
N	3	7	230408.6	487
O	4	8	289023.5	086
F	5	9	347438.	487
NE	6	10	*406056.*	071
NA	7	11	465111.	487
MG	8	12	524486.	487
AL	9	13	584390.	487
SI	10	14	644940.	487
P	11	15	(703800.)	374
S	12	16	(763500.)	374
CL	13	17	(823000.)	374

1S2			2P3( )	2D* 2
B	1	5	(99800.)	374
C	02	06	150467.12	287
N	3	7	203088.9	487
O	4	8	255184.9	086
F	5	9	307273.	487
NE	6	10	(359700.)	374
NA	7	11	412395.	487
MG	8	12	465738.	487
AL	9	13	519740.	487
SI	10	14	574600.	487
P	11	15	(628600.)	374
S	12	16	(683400.)	374

1S2			2P3( )	2D* 3
B	1	5	(99800.)	374
C	02	06	150462.01	287
N	3	7	203072.2	487
O	4	8	255155.9	086
F	5	9	307226.	487
NE	6	10	(359600.)	374
NA	7	11	412311.	487
MG	8	12	465598.	487
AL	9	13	519560.	487
SI	10	14	574360.	487
P	11	15	(628300.)	374
S	12	16	(683000.)	374

1S2			2P2(1D) 3S	2D 2
N	3	7	(421000.)	374
O	4	8	600092.	487
F	5	9	811075.	487
NE	6	10	(1055000.)	374
NA	7	11	1331137.	487
MG	8	12	1638646.	487
AL	9	13	(1979000.)	374

1S2			2P2(1D) 3S 2D 3	
N	3	7	(421000.)	374
O	4	8	600106.	487
F	5	9	811075.	487
NE	6	10	(1055000.)	374
NA	7	11	1331974.	487
MG	8	12	1638646.	487
AL	9	13	(1979000.)	374

1S2			2P2(1D) 3P 2D* 2	
O	4	8	(633000.)	374
F	5	9	*854971.*	487
NE	6	10	(1108000.)	374
NA	7	11	1392764.	487
MG	8	12	1708860.	487
AL	9	13	2056120.	487
SI	10	14	(2435000.)	374
P	11	15	(2845000.)	374

1S2			2P2(1D) 3P 2D* 3	
O	4	8	(633000.)	374
F	5	9	854971.	487
NE	6	10	(1108000.)	374
NA	7	11	1392764.	487
MG	8	12	1708860.	487
AL	9	13	2056120.	487
SI	10	14	(2435000.)	374
P	11	15	(2845000.)	374

1S2			2P2(1D) 3P 2F* 3	
N	3	7	(436500.)	374
O	4	8	624882.	487
F	5	9	844112.	487
NE	6	10	(1095000.)	374
NA	7	11	1377822.	487
MG	8	12	1691070.	487
AL	9	13	(2036000.)	374

1S2			2P2(1D) 3P 2F* 4	
N	3	7	(436500.)	374
O	4	8	624882.	487
F	5	9	844266.	487
NE	6	10	(1095000.)	374
NA	7	11	1378295.	487
MG	8	12	1691070.	487
AL	9	13	(2036000.)	374

1S2			2P2(1D) 3D 2P 1	
N	3	7	(455000.)	374
O	4	8	653411.	487
F	5	9	882930.	487
NE	6	10	(1142200.)	374
NA	7	11	1432135.	487
MG	8	12	1753323.	691
AL	9	13	(2104000.)	374

1S2		2P2(1D) 3D	2P 2
N	3 7	(455000.)	374
O	4 8	653328.	487
F	5 9	883083.	487
NE	6 10	(1142500.)	374
NA	7 11	1432606.	487
MG	8 12	1754288.	691
AL	9 13	(2106000.)	374

1S2	2S	2P (3P*) 3S	4P* 1
B	1 5	(77100.)	374
C	02 06	166967.56	287
N	3 7	287535.6	487
O	4 8	438849.0	086
F	5 9	620810.	487
NE	6 10	(835100.)	374
NA	7 11	*1076584.*	487
MG	8 12	*1352123.*	487
AL	9 13	*1657690.*	487
SI	10 14	*1993860.*	487
P	11 15	*2379730.*	487

1S2	2S	2P (3P*) 3S	4P* 2
B	1 5	(77100.)	374
C	02 06	166991.16	287
N	3 7	287598.1	487
O	4 8	438983.9	086
F	5 9	621067.	487
NE	6 10	835595.	071
NA	7 11	*1077316.*	487
MG	8 12	*1353279.*	487
AL	9 13	*1659350.*	487
SI	10 14	*1996180.*	487
P	11 15	*2376130.*	487

1S2	2S	2P (3P*) 3S	4P* 3
B	1 5	(77100.)	374
C	02 06	167036.14	287
N	3 7	287713.9	487
O	4 8	439230.9	086
F	5 9	621535.	487
NE	6 10	836407.	071
NA	7 11	*1078646.*	487
MG	8 12	*1355296.*	487
AL	9 13	*1662340.*	487
SI	10 14	*2000570.*	487
P	11 15	*2369930.*	487

TABLE VII BORON ISOELECTRONIC SEQUENCE (cont.)

1S2 2S 2P (3P*) 3S 2P* 1

B	1	5	(84800.)	374
C	02	06	177775.02	287
N	3	7	297150.2	487
O	4	8	452806.6	086
F	5	9	638856.	487
NE	6	10	(854800.)	374
NA	7	11	1103222.	487
MG	8	12	1381466.	487
AL	9	13	1690880.	487
SI	10	14	(2032000.)	374
P	11	15	2410070.	487
P	11	15	(2405000.)	374

1S2 2S 2P (3P*) 3S 2P* 2

B	1	5	(84800.)	374
C	02	06	177793.97	287
N	3	7	297263.1	487
O	4	8	453071.5	086
F	5	9	639365.	487
NE	6	10	(855800.)	374
NA	7	11	1104620.	487
MG	8	12	1383731.	487
AL	9	13	1694110.	487
SI	10	14	2035810.	487
P	11	15	2410070.	487

1S2 2S 2P (1P*) 3S 2P* 1

C	2	6	(235000.)	374
N	3	7	(359000.)	374
O	4	8	518684.	487
F	5	9	712755.	487
NE	6	10	(940000.)	374
NA	7	11	1198287.	487
MG	8	12	1486995.	487
AL	9	13	1807020.	487
SI	10	14	2158290.	487
P	11	15	2541040.	487
S	12	16	(2957000.)	374

1S2 2S 2P (1P*) 3S 2P* 2

C	2	6	(235000.)	374
N	3	7	(359000.)	374
O	4	8	518690.	487
F	5	9	712755.	487
NE	6	10	(940000.)	374
NA	7	11	1198287.	487
MG	8	12	1486995.	487
AL	9	13	1807020.	487
SI	10	14	2158290.	487
P	11	15	2541040.	487
S	12	16	(2957000.)	374

TABLE VII BORON ISOELECTRONIC SEQUENCE (cont.)

1S2 2S 2P (3P*) 3P 4S 2

B	1	5	(86200.)	374
C	02	06	184691.41	287
N	3	7	314224.0	487
O	4	8	474478.1	086
F	5	9	665912.	487
NE	6	10	(888000.)	374
NA	7	11	(1141000.)	374

1S2 2S 2P (3P*) 3P 2S 1

C	2	6	(199000.)	374
N	3	7	327056.8	487
O	4	8	492890.9	086
F	5	9	687806.	487
NE	6	10	900408.	487
NA	7	11	1172339.	487
MG	8	12	1460911.	487
AL	9	13	1780950.	487
SI	10	14	(2140000.)	374

1S2 2S 2P (1P*) 3P 2S 1

N	3	7	(381000.)	374
O	4	8	554461.	487
F	5	9	760342.	487
NE	6	10	(994000.)	374
NA	7	11	1258878.	487
MG	8	12	1556517.	487
AL	9	13	(1883000.)	374

1S2 2S 2P (3P*) 3P 2P 1

B	1	5	(86000.)	374
C	02	06	182024.29	287
N	3	7	309132.6	487
O	4	8	467229.3	086
F	5	9	656208.	487
NE	6	10	878852.	487
NE	6	10	(876100.)	374
NA	7	11	1126810.	487
MG	8	12	1408371.	487
AL	9	13	1720900.	487
SI	10	14	(2064400.)	374
P	11	15	(2439000.)	374
S	12	16	(2845000.)	374

1S2 2S 2P (3P*) 3P 2P 2

B	1	5	(86000.)	374
C	02	06	182043.84	287
N	3	7	309185.8	487
O	4	8	467344.9	086
F	5	9	656436.	487
NE	6	10	878852.	487
NE	6	10	(876500.)	374
NA	7	11	1127431.	487
MG	8	12	1409401.	487
AL	9	13	1722400.	487
SI	10	14	2066600.	487
P	11	15	(2442000.)	374
S	12	16	(2849000.)	374

TABLE VII BORON ISOELECTRONIC SEQUENCE (cont.)

1S2 2S 2P (1P*) 3P 2P 1

C	2	6	(237000.)	374
N	3	7	377591.	487
O	4	8	549792.	487
F	5	9	753529.	487
NE	6	10	(987300.)	374
NA	7	11	1253353.	487
MG	8	12	1549955.	487
AL	9	13	1878390.	487
SI	10	14	(2238000.)	374

1S2 2S 2P (1P*) 3P 2P 2

C	2	6	(237000.)	374
N	3	7	377608.	487
O	4	8	549855.	487
F	5	9	753656.	487
NE	6	10	(987600.)	374
NA	7	11	1253779.	487
MG	8	12	1550564.	487
AL	9	13	1878390.	487
AL	9	13	(1879500.)	374
SI	10	14	(2240000.)	374

1S2 2S 2P (3P*) 3P 2D 2

B	1	5	(86000.)	374
C	02	06	188581.68	287
N	3	7	320977.4	487
O	4	8	482666.1	086
F	5	9	675932.	487
NE	6	10	906373.	487
NE	6	10	(900000.)	374
NA	7	11	1154779.	487
MG	8	12	1440561.	487
AL	9	13	1757500.	487
SI	10	14	(2105000.)	374
P	11	15	(2483000.)	374

1S2 2S 2P (3P*) 3P 2D 3

B	1	5	(86000.)	374
C	02	06	188615.50	287
N	3	7	321065.8	487
O	4	8	482921.6	086
F	5	9	676422.	487
NE	6	10	906373.	487
NE	6	10	(900800.)	374
NA	7	11	1156180.	487
MG	8	12	1442836.	487
AL	9	13	1760970.	487
SI	10	14	2110260.	487
P	11	15	(2490000.)	374

TABLE VII BORON ISOELECTRONIC SEQUENCE (cont.)

1S2 2S 2P (1P*) 3P 2D 2

C	2	6	(231000.)	374
N	3	7	373342.	487
O	4	8	547311.	487
F	5	9	751406.	487
NE	6	10	(986200.)	374
NA	7	11	1251674.	487
MG	8	12	1548027.	487
AL	9	13	1875340.	487
SI	10	14	(2233000.)	374
P	11	15	(2621000.)	374

1S2 2S 2P (1P*) 3P 2D 3

C	2	6	(231000.)	374
N	3	7	373376.	487
O	4	8	547336.	487
F	5	9	751452.	487
NE	6	10	(986400.)	374
NA	7	11	1252014.	487
MG	8	12	1548851.	487
AL	9	13	1876710.	487
SI	10	14	(2235000.)	374
P	11	15	(2624000.)	374

1S2 2S 2P (3P*) 3D 4P* 1

B	1	5	(92070.)	374
C	02	06	198879.44	287
N	3	7	336303.1	487
O	4	8	504282.3	086
F	5	9	702931.	487
NE	6	10	(932150.)	374
NA	7	11	*1192528.*	487
MG	8	12	*1485639.*	487
AL	9	13	*1809210.*	487

1S2 2S 2P (3P*) 3D 4P* 2

B	1	5	(92070.)	374
C	02	06	198865.68	287
N	3	7	336268.0	487
O	4	8	504208.9	086
F	5	9	702789.	487
NE	6	10	(931900.)	374
NA	7	11	*1192185.*	487
MG	8	12	*1485153.*	487
AL	9	13	*1808530.*	487

1S2 2S 2P (3P*) 3D 4P* 3

B	1	5	(92070.)	374
C	02	06	198844.43	287
N	3	7	336213.4	487
O	4	8	504095.7	086
F	5	9	702580.	487
NE	6	10	(931600.)	374
NA	7	11	*1191664.*	487
MG	8	12	*1484449.*	487
AL	9	13	*1807490.*	487
SI	10	14	*2161950.*	487
P	11	15	*2547290.*	487

TABLE VII BORON ISOELECTRONIC SEQUENCE (cont.)

1S2 2S 2P (3P*) 3D 2P* 1

B	1	5	(93840.)	374
C	02	06	202204.95	287
N	3	7	342763.7	487
O	4	8	514371.3	086
F	5	9	718691.	487
NE	6	10	(952600.)	374
NA	7	11	1217955.	487
MG	8	12	1514266.	487
AL	9	13	1842220.	487
SI	10	14	2201770.	487
P	11	15	2593090.	487
S	12	16	(3017500.)	374
CL	13	17	(3476000.)	374

1S2 2S 2P (3P*) 3D 2P* 2

B	1	5	(93840.)	374
C	02	06	202180.28	287
N	3	7	342693.0	487
O	4	8	514220.4	086
F	5	9	718472.	487
NE	6	10	(952200.)	374
NA	7	11	1217189.	487
MG	8	12	1513099.	487
AL	9	13	1840470.	487
SI	10	14	2199190.	487
P	11	15	2589460.	487
S	12	16	(3012500.)	374
CL	13	17	(3469000.)	374

1S2 2S 2P (1P*) 3D 2P* 1

N	3	7	(404800.)	374
O	4	8	581721.	487
F	5	9	793308.	487
NE	6	10	(1035000.)	374
NA	7	11	1306468.	487
MG	8	12	1610669.	487
AL	9	13	1954710.	487
SI	10	14	(2349000.)	374

1S2 2S 2P (1P*) 3D 2P* 2

N	3	7	(404800.)	374
O	4	8	581743.	487
F	5	9	793308.	487
NE	6	10	(1035000.)	374
NA	7	11	1306468.	487
MG	8	12	1610669.	487
AL	9	13	1954710.	487
SI	10	14	(2349000.)	374

1S2 2S 2P (3P*) 3D 2D* 2

B	1	5	(93300.)	374
C	02	C6	198425.86	287
N	3	7	334542.2	487
O	4	8	501509.2	086
F	5	9	699293.	487
NE	6	10	(928000.)	374
NA	7	11	(1187612.)	375
MG	8	12	1478358.	487
AL	9	13	1800460.	487
SI	10	14	2153680.	487
P	11	15	2539140.	487
S	12	16	(2956500.)	374
CL	13	17	(3406500.)	374
AR	14	18	(3890000.)	374

1S2 2S 2P (3P*) 3D 2D* 3

B	1	5	(93300.)	374
C	02	06	198436.74	287
N	3	7	334568.9	487
O	4	8	501564.4	086
F	5	9	699389.	487
NE	6	10	(928150.)	374
NA	7	11	1187885.	487
MG	8	12	1478706.	487
AL	9	13	1800910.	487
SI	10	14	2154440.	487
P	11	15	2540050.	487
S	12	16	(2958000.)	374
CL	13	17	(3408000.)	374
AR	14	18	(3892000.)	374

1S2 2S 2P (1P*) 3D 2D* 2

C	2	6	(248600.)	374
N	3	7	396574.9	487
O	4	8	575819.	487
F	5	9	787725.	487
NE	6	10	(1029900.)	374
NA	7	11	1303445.	487
MG	8	12	1607872.	487
AL	9	13	1943380.	487
SI	10	14	2310230.	487
P	11	15	2707510.	487
S	12	16	(3136500.)	374
CL	13	17	(3597000.)	374
AR	14	18	(4089000.)	374

1S2 2S 2P (1P*) 3D 2D* 3

C	2	6	(248600.)	374
N	3	7	396584.8	487
O	4	8	575853.	487
F	5	9	787764.	487
NE	6	10	(1030000.)	374
NA	7	11	1303643.	487
MG	8	12	1608224.	487
AL	9	13	1943980.	487
SI	10	14	2311360.	487
P	11	15	2709400.	487
S	12	16	(3139500.)	374
CL	13	17	(3602000.)	374
AR	14	18	(4096000.)	374

1S2 2S 2P (3P*) 3D 2F* 3

B	1	5	(91700.)	374
C	02	06	199941.84	287
N	3	7	339744.4	487
O	4	8	510744.9	086
F	5	9	712840.	487
NE	6	10	(945900.)	374
NA	7	11	1209908.	487
MG	8	12	1504992.	487
AL	9	13	1831260.	487
SI	10	14	2188570.	487
P	11	15	2578000.	487
S	12	16	(2999000.)	374
CL	13	17	(3453000.)	374
AR	14	18	(3940000.)	374

1S2 2S 2P (3P*) 3D 2F* 4

B	1	5	(91700.)	374
C	02	06	199983.67	287
N	3	7	339855.7	487
O	4	8	510977.2	086
F	5	9	713306.	487
NE	6	10	(946700.)	374
NA	7	11	1211236.	487
MG	8	12	1507043.	487
AL	9	13	1834300.	487
SI	10	14	2193140.	487
P	11	15	2584000.	487
S	12	16	(3007000.)	374
CL	13	17	(3463000.)	374
AR	14	18	(3953000.)	374

TABLE VII BORON ISOELECTRONIC SEQUENCE (cont.)

1S2 2S 2P (1P*) 3D 2F* 3

N	3	7	(395000.)	374
O	4	8	570791.	487
F	5	9	783650.	487
NE	6	10	(1022000.)	374
NA	7	11	1292333.	487
MG	8	12	1597469.	487
AL	9	13	1933050.	487
SI	10	14	2299860.	487
P	11	15	2697820.	487
S	12	16	(3128000.)	374

1S2 2S 2P (1P*) 3D 2F* 4

N	3	7	(395000.)	374
O	4	8	570791.	487
F	5	9	783650.	487
NE	6	10	(1022000.)	374
NA	7	11	1292333.	487
MG	8	12	1597469.	487
AL	9	13	1933050.	487
SI	10	14	2299860.	487
P	11	15	2697820.	487
S	12	16	(3128000.)	374

1S2 2S 2P (3P*) 4D 2F* 3

B	1	5	(96000.)	374
C	02	06	221461.31	287
N	3	7	387728.7	487
O	4	8	596295.	086
F	5	9	847506.	487
NE	6	10	(1138500.)	374
NA	7	11	1471559.	487
MG	8	12	1846146.	487
AL	9	13	(2262400.)	374
SI	10	14	(2720000.)	374

1S2 2S 2P (3P*) 4D 2F* 4

B	1	5	(96000.)	374
C	02	06	221503.76	287
N	3	7	387811.5	487
O	4	8	596475.	086
F	5	9	847817.	487
NE	6	10	(1139100.)	374
NA	7	11	1472727.	487
MG	8	12	1848025.	487
AL	9	13	2265580.	487
SI	10	14	(2724000.)	374

TABLE VIII

TRANSITIONS - BORON ISOELECTRONIC SEQUENCE

		B I	C II	N III	O IV	F V	Ne VI	Na VII
$2s^2 2p - 2s^2 3s$	$^2P^o_{3/2} - ^2S_{1/2}$	2498.48	858.56	452.23	279.93	190.84	138.64	105.35
$2s^2 2p - 2s^2 4s$	$^2P^o_{3/2} - ^2S_{1/2}$	1818.35	636.25	332.32	206.00	140.41	(101.87)	77.35
$2s^2 2p - 2s2p^2$	$^2P^o_{3/2} - ^2S_{1/2}$	1573.67	1037.02	764.36	609.83	508.08	435.65	381.30
$2s^2 3s - 2s^2 3p$	$^2S_{1/2} - ^2P^o_{3/2}$	11663.24	6579.87	4098.48	3064.35	2451.40	2043.04	1752.20
$2s2p^2 - 1s^2 2p^3$	$^2S_{1/2} - ^2P^o_{3/2}$	(2103.09)	1383.99	1005.98	802.20	667.23	570.77	498.23
	$^2P_{3/2} - ^2D^o_{5/2}$	(3669.32)	2512.81	1751.75	1343.51	1088.40	(913.34)	778.05
$2s2p(^3P^o)3s - (^3P^o)3p$	$^2P^o_{3/2} - ^2P_{3/2}$	(83333.3)	23530.1	8387.36	7005.99	5857.89	(4830.92)	4384.00
	$^2P^o_{3/2} - ^2D_{5/2}$	(83333.3)	9210.20	4201.20	3350.07	2698.55	(2222.22)	1939.49
$2s2p(^1P^o)3s - (^1P^o)3p$	$^2P^o_{3/2} - ^2P_{3/2}$		(50000)	(5374.03)	3208.73	2444.93	(2100.84)	1802.06
	$^2P^o_{3/2} - ^2D_{5/2}$			(6956.04)	3490.89	2584.18	(2155.17)	1861.26
$2s2p(^3P^o)3p - (^3P^o)3d$	$^2P_{3/2} - ^2P^o_{3/2}$	(12755.1)	4966.12	2984.43	2133.54	1611.97	(1321.00)	1411.11
	$^2P_{3/2} - ^2D^o_{5/2}$	(13698.7)	6100.20	3939.63	2922.28	2328.13	(1936.11)	1654.15
	$^2D_{5/2} - ^2F^o_{7/2}$	(17543.9)	8770.40	5297.09	3532.20	2675.66	2141.33	1816.33
$2s2p(^1P^o)3p - (^1P^o)3d$	$^2P_{3/2} - ^2D^o_{5/2}$		(8620.69)	5269.59	3846.45	2931.86	(2358.49)	2005.45
	$^2D_{5/2} - ^2F^o_{7/2}$			(4624.45)	4263.48	3105.78	(2808.99)	2480.22
$2s2p(^3P^o)3p - (^3P^o)4d$	$^2D_{5/2} - ^2F^o_{7/2}$	(10000.0)	3040.59	1498.22	880.64	583.45	(419.64)	317.08

Note: Transitions in Angstroms. (   ) indicates prediction.

TABLE VIII

TRANSITIONS - BORON ISOELECTRONIC SEQUENCE (continued)

		Mg VIII	Al IX	Si X	P XI	S XII	Cl XIII	Ar XIV
$2s^2 2p$ - $2s^2 3s$	$^2P^o_{3/2}$ - $^2S_{1/2}$	82.82	66.84	(55.10)	46.20	(39.28)	(33.87)	(29.49)
$2s^2 2p$ - $2s^2 4s$	$^2P^o_{3/2}$ - $^2S_{1/2}$	60.81	(49.07)	(40.42)				
$2s^2 2p$ - $2s2p^2$	$^2P^o_{3/2}$ - $^2S_{1/2}$	339.01	300.62	277.27	254.05	(233.99)	(216.64)	(201.26)
$2s^2 3s$ - $2s^2 3p$	$^2S_{1/2}$ - $^2O^o_{3/2}$	(1531.14)	(1351.72)					
$2s2p^2$ - $1s^2 2p^3$	$^2S_{1/2}$ - $^2P^o_{3/2}$	442.28	397.24	360.63	(332.81)	(309.60)	(290.70)	
	$^2P_{3/2}$ - $^2D^o_{5/2}$	690.34	614.97	554.45	(508.52)	(462.96)		
$2s2p(^3P^o)3s$ - $(^3P^o)3p$	$^2P^o_{3/2}$ - $^2P_{3/2}$	3895.60	3534.82	3247.81	(3131.85)			
	$^2P^o_{3/2}$ - $^2D_{5/2}$	1691.90	1495.66	1343.18	(1251.09)			
$2s2p(^1P^o)3s$ - $(^1P^o)3p$	$^2P^o_{3/2}$ - $^2P_{3/2}$	1573.09	1401.15	(1223.84)				
	$^2P^o_{3/2}$ - $^2D_{5/2}$	1616.66	1434.93	(1303.61)	(1205.40)			
$2s2p(^3P^o)3p$ - $(^3P^o)3d$	$^2P_{3/2}$ - $^2P^o_{3/2}$	964.34	846.96	754.20	(678.15)	(611.62)		
	$^2P_{3/2}$ - $^2D_{5/2}$	1442.90	1273.72	1138.43	(1019.89)	(917.43)		
	$^2D_{5/2}$ - $^2F_{7/2}$	1557.46	1363.70	1206.56	(1063.83)			
$2s2p(^1P^o)3p$ - $(^1P^o)3d$	$^2P_{3/2}$ - $^2D^o_{5/2}$	1734.30	(1550.87)	(1401.35)				
	$^2D_{5/2}$ - $^2F^o_{7/2}$	2056.85	1774.94	(1541.78)	(1354.65)			
$2s2p(^3P^o)3p$ - $(^3P^o)4d$	$^2D_{5/2}$ - $^2F^o_{7/2}$	246.80	(198.06)	(162.94)				

TABLE IX CARBON ISOELECTRONIC SEQUENCE

1S2 2S2 2P2( ) G 3P 1

C	1	6	16.40	821
N	2	7	48.7	200
O	3	8	113.4	487
F	4	9	225.2	487
NE	5	10	414.	487
NA	6	11	698.	487
MG	7	12	1127.	487
AL	8	13	1740.	487
SI	9	14	2590.	487
P	10	15	3390.	487
S	11	16	5210.	161
CL	12	17	7190.	161
AR	13	18	9870.	161
K	14	19	*13220.*	161T
CA	15	20	17556.	487
SC	16	21	(22900.)	374
TI	17	22	(29500.)	374
V	18	23	(37500.)	374

1S2 2S2 2P2( ) G 3P 2

C	1	6	43.40	821
N	2	7	130.8	200
O	3	8	306.8	487
F	4	9	613.4	487
NE	5	10	1112.	487
NA	6	11	1858.	487
MG	7	12	2939.	487
AL	8	13	4440.	487
SI	9	14	6460.	487
P	10	15	8580.	487
S	11	16	12400.	161
CL	12	17	16570.	161
AR	13	18	21850.	161
K	14	19	*28060.*	161T
CA	15	20	35911.	487
SC	16	21	(45200.)	374
TI	17	22	(56100.)	374
V	18	23	(68900.)	374

1S2 2S2 2P2( ) 1S 0

C	1	6	21648.01	821
N	2	7	32688.8	200
O	3	8	43183.5	487
F	4	9	53544.	487
NE	5	10	63900.	487
NA	6	11	*74394.*	487
MG	7	12	*85109.*	487
AL	8	13	*96170.*	487
SI	9	14	*107780.*	487
P	10	15	119430.	487
S	11	16	(131000.)	374
CL	12	17	*158990.*	161
AR	13	18	*175720.*	161
K	14	19	*186370.*	161T
CA	15	20	*207340.*	161T

TABLE IX CARBON ISOELECTRONIC SEQUENCE (cont.)

1S2 2S 2P3( ) 3D* 1

C	1	6	64089.85	821
N	2	7	92251.8	200
O	3	8	120058.5	487
F	4	9	147901.6	487
NE	5	10	175927.	487
NA	6	11	204260.	487
MG	7	12	233027.	487
AL	8	13	262390.	487
SI	9	14	292440.	487
P	10	15	323160.	487
S	11	16	(349000.)	374
CL	12	17	(378000.)	374
AR	13	18	(406000.)	374

1S2 2S 2P3( ) 3D* 2

C	1	6	64090.95	821
N	2	7	92250.3	200
O	3	8	120052.6	487
F	4	9	147888.9	487
NE	5	10	175905.	487
NA	6	11	204222.	487
MG	7	12	232975.	487
AL	8	13	262320.	487
SI	9	14	292360.	487
P	10	15	323010.	487
S	11	16	(349000.)	374
CL	12	17	(378000.)	374
AR	13	18	(406000.)	374

1S2 2S 2P3( ) 3D* 3

C	1	6	64086.92	821
N	2	7	92237.2	200
O	3	8	120025.4	487
F	4	9	147841.8	487
NE	5	10	175834.	487
NA	6	11	204131.	487
MG	7	12	232865.	487
AL	8	13	262190.	487
SI	9	14	292210.	487
P	10	15	322790.	487
S	11	16	(349000.)	374
CL	12	17	(378000.)	374
AR	13	18	(406000.)	374

1S2 2S2 2P (2P*) 3S 3P* 0

C	1	6	60333.43	821
N	2	7	148908.59	200
O	3	8	267257.29	487
F	4	9	416417.3	487
NE	5	10	596258.	KA60
NA	6	11	(806700.)	374
MG	7	12	1047624.	487
AL	8	13	1319280.	487
SI	9	14	(1621000.)	374
P	10	15	1954140.	487
S	11	16	(2317000.)	374
CL	12	17	(2711000.)	374
AR	13	18	(3136000.)	374

1S2 2S2 2P (2P*) 3S 3P* 1

C	1	6	60352.63	821
N	2	7	148940.17	200
O	3	8	267375.65	487
F	4	9	416639.8	487
NE	5	10	596626.	487
NA	6	11	807324.	487
MG	7	12	1048385.	487
AL	8	13	1320450.	487
SI	9	14	1623380.	487
P	10	15	1955980.	487
S	11	16	(2320000.)	374
CL	12	17	(2714000.)	374
AR	13	18	(3139000.)	374

1S2 2S2 2P (2P*) 3S 3P* 2

C	1	6	60393.14	821
N	2	7	149076.52	200
O	3	8	267632.59	487
F	4	9	417143.4	487
NE	5	10	597528.	KA60
NA	6	11	808795.	487
MG	7	12	1050906.	487
AL	8	13	1324080.	487
SI	9	14	1628550.	487
P	10	15	1963430.	487
S	11	16	(2329000.)	374
CL	12	17	(2726000.)	374
AR	13	18	(3153000.)	374

TABLE IX CARBON ISOELECTRONIC SEQUENCE (cont.)

1S2 2S2 2P (2P*) 3S 1P* 1

C	1	6	61981.82	821
N	2	7	149187.80	200
O	3	8	273080.07	487
F	4	9	423606.4	487
NE	5	10	605231.	487
NA	6	11	817718.	487
MG	7	12	*1060996.*	487
AL	8	13	*1335270.*	487
SI	9	14	*1640920.*	487
P	10	15	1976578.	487
S	11	16	(2343000.)	374
CL	12	17	(2740000.)	374
AR	13	18	(3168000.)	374

1S2 2S2 2P (2P*) 3P 3S 1

C	1	6	70743.95	821
N	2	7	168892.21	200
O	3	8	297557.50	487
F	4	9	456884.3	487
NE	5	10	(646900.)	374
NA	6	11	(867800.)	374
MG	7	12	(1119000.)	374
AL	8	13	1402180.	487
SI	9	14	(1716000.)	374

1S2 2S2 2P (2P*) 3P 1S 0

C	1	6	73975.91	821
N	2	7	178273.38	200
O	3	8	313801.07	487
F	4	9	(480600.)	374
NE	5	10	(678500.)	374

1S2 2S2 2P (2P*) 3P 3P 0

C	1	6	71352.51	821
N	2	7	170572.61	200
O	3	8	300228.21	487
F	4	9	460215.2	487
NE	5	10	(650700.)	374
NA	6	11	(871800.)	374
MG	7	12	1123745.	487
AL	8	13	(1407000.)	374
SI	9	14	(1720000.)	374

1S2 2S2 2P (2P*) 3P 3P 1

C	1	6	71364.90	821
N	2	7	170607.89	200
O	3	8	300310.31	487
F	4	9	460385.8	487
NE	5	10	(651100.)	374
NA	6	11	872577.	487
MG	7	12	1124937.	487
AL	8	13	(1408000.)	374
SI	9	14	(1721000.)	374

1S2 2S2 2P (2P*) 3P 3P 2

C	1	6	71385.38	821
N	2	7	170666.23	200
O	3	8	300440.85	487
F	4	9	460640.6	487
NE	5	10	(651600.)	374
NA	6	11	873287.	487
MG	7	12	1125850.	487
AL	8	13	(1409000.)	374
SI	9	14	(1722000.)	374

1S2 2S2 2P (2P*) 3P 1P 1

C	1	6	68856.33	821
N	2	7	164610.76	200
O	3	8	290956.62	487
F	4	9	(447900.)	374
NE	5	10	(635400.)	374

1S2 2S2 2P (2P*) 3P 3D 1

C	1	6	69689.48	821
N	2	7	166521.69	200
O	3	8	293865.26	487
F	4	9	451819.6	487
NE	5	10	640422.	KA60
NA	6	11	(859600.)	374
MG	7	12	(1109000.)	374

1S2 2S2 2P (2P*) 3P 3D 2

C	1	6	69710.66	821
N	2	7	166582.45	200
O	3	8	294001.60	487
F	4	9	452081.1	487
NE	5	10	640868.	KA60
NA	6	11	(860200.)	374
MG	7	12	(1110000.)	374

1S2 2S2 2P (2P*) 3P 3D 3

C	1	6	69744.03	821
N	2	7	166678.64	200
O	3	8	294221.65	487
F	4	9	452517.1	487
NE	5	10	641651.	KA60
NA	6	11	(861400.)	374
MG	7	12	(1112000.)	374

1S2 2S2 2P (2P*) 3P 1D 2

C	1	6	72610.72	821
N	2	7	174212.03	200
O	3	8	306584.8	487
F	4	9	469644.2	487
NE	5	10	(663500.)	374
NA	6	11	(888000.)	374

TABLE IX CARBON ISOELECTRONIC SEQUENCE (cont.)

1S2 2S2 2P (2P*) 3D 3P* 0

C	1	6	79323.16	821
N	2	7	188937.24	200
O	3	8	329643.43	487
F	4	9	500716.5	487
NE	5	10	702459.	487
NA	6	11	934745.	487
MG	7	12	1197872.	487
AL	8	13	1492140.	487
SI	9	14	1817670.	487
P	10	15	2173990.	487
S	11	16	(2562000.)	374
CL	12	17	(2982000.)	374
AR	13	18	(3434000.)	374

1S2 2S2 2P (2P*) 3D 3P* 1

C	1	6	79318.78	821
N	2	7	188909.17	200
O	3	8	329581.98	487
F	4	9	500602.1	487
NE	5	10	702074.	487
NA	6	11	934463.	487
MG	7	12	1197469.	487
AL	8	13	1491570.	487
SI	9	14	1816940.	487
P	10	15	2173040.	487
S	11	16	(2561000.)	374
CL	12	17	(2981000.)	374
AR	13	18	(3432000.)	374

1S2 2S2 2P (2P*) 3D 3P* 2

C	1	6	79310.85	821
N	2	7	188857.37	200
O	3	8	329467.98	487
F	4	9	500390.1	487
NE	5	10	701765.	487
NA	6	11	933915.	487
MG	7	12	1196770.	487
AL	8	13	1490590.	487
SI	9	14	1815690.	487
P	10	15	2171630.	487
S	11	16	(2559000.)	374
CL	12	17	(2979000.)	374
AR	13	18	(3429000.)	374

TABLE IX CARBON ISOELECTRONIC SEQUENCE (cont.)

1S2 2S2 2P (2P*) 3D 1P* 1

C	1	6	78731.27	821
N	2	7	190120.24	200
O	3	8	332777.1	487
F	4	9	506514.	487
NE	5	10	702412.	487
NA	6	11	*946512. *	487
MG	7	12	*1212759.*	487
AL	8	13	*1510060.*	487
SI	9	14	1838540.	487
P	10	15	2197500.	487
S	11	16	(2589000.)	374
CL	12	17	(3013000.)	374
AR	13	18	(3468000.)	374

1S2 2S2 2P (2P*) 3D 3D* 1

C	1	6	78293.49	821
N	2	7	187437.56	200
O	3	8	327227.94	487
F	4	9	497481.4	487
NE	5	10	698231.	487
NA	6	11	929774.	487
MG	7	12	1191753.	487
AL	8	13	1484560.	487
SI	9	14	1808160.	487
P	10	15	2162410.	487
S	11	16	(2547000.)	374
CL	12	17	(2962000.)	374
AR	13	18	(3408000.)	374
K	14	19	(3885000.)	374

1S2 2S2 2P (2P*) 3D 3D* 2

C	1	6	78307.63	821
N	2	7	187461.56	200
O	3	8	327277.18	487
F	4	9	497575.6	487
NE	5	10	698382.	487
NA	6	11	929999.	487
MG	7	12	1192185.	487
AL	8	13	1485240.	487
SI	9	14	1809080.	487
P	10	15	2163500.	487
S	11	16	(2548000.)	374
CL	12	17	(2964000.)	374
AR	13	18	(3410000.)	374
K	14	19	(3888000.)	374

TABLE IX CARBON ISOELECTRONIC SEQUENCE (cont.)

1S2 2S2 2P (2P*) 3D 3D* 3

C	1	6	78318.25	821
N	2	7	187491.90	200
O	3	8	327350.90	487
F	4	9	497729.1	487
NE	5	10	698735.	487
NA	6	11	930510.	487
MG	7	12	1193061.	487
AL	8	13	1486710.	487
SI	9	14	1811480.	487
P	10	15	2166800.	487
S	11	16	(2552000.)	374
CL	12	17	(2969000.)	374
AR	13	18	(3417000.)	374
K	14	19	(3895000.)	374

1S2 2S2 2P (2P*) 3D 1D* 2

C	1	6	77679.82	821
N	2	7	187091.37	200
O	3	8	324734.22	487
F	4	9	492864.	487
NE	5	10	690691.	487
NA	6	11	*920826.*	487
MG	7	12	*1180886.*	487
AL	8	13	*1471980.*	487
SI	9	14	1794090.	487
P	10	15	2147190.	487
S	11	16	(2531000.)	374
CL	12	17	2955760.	269
AR	13	18	(3388000.)	374
K	14	19	(3862000.)	374

1S2 2S2 2P (2P*) 3D 3F* 2

C	1	6	78199.07	821
N	2	7	186511.58	200
O	3	8	324462.46	487
F	4	9	492395.1	487
NE	5	10	(690000.)	374
NA	6	11	919476.	487
MG	7	12	*1178758.*	487
AL	8	13	*1468700.*	487
SI	9	14	*1789000.*	487
P	10	15	2140410.	487
S	11	16	(2521000.)	374

TABLE IX CARBON ISOELECTRONIC SEQUENCE (cont.)

1S2 2S2 2P (2P*) 3D 3F* 3

C	1	6	78215.51	821
N	2	7	186570.98	200
O	3	8	324658.25	487
F	4	9	492858.8	487
NE	5	10	(690900.)	374
NA	6	11	919476.	487
MG	7	12	*1178758.*	487
AL	8	13	*1468700.*	487
SI	9	14	*1789000.*	487
P	10	15	2140400.	487
S	11	16	(2521000.)	374

1S2 2S2 2P (2P*) 3D 3F* 4

C	1	6	78249.94	821
N	2	7	186652.49	200
O	3	8	324836.41	487
F	4	9	493206.2	487
NE	5	10	(691500.)	374
NA	6	11	919476.	487
MG	7	12	*1178758.*	487
AL	8	13	*1468700.*	487
SI	9	14	*1789000.*	487
P	10	15	2140400.	487
S	11	16	(2521000.)	374

1S2 2S2 2P (2P*) 3D 1F* 3

C	1	6	78529.62	821
N	2	7	189335.16	200
O	3	8	331820.2	487
F	4	9	505421.4	487
NE	5	10	709956.	487
NA	6	11	*945429.*	487
MG	7	12	*1211785.*	487
AL	8	13	*1509210.*	487
SI	9	14	1837810.	487
P	10	15	2197500.	487
S	11	16	(2588000.)	374
CL	12	17	(3010000.)	374
AR	13	18	(3463000.)	374
K	14	19	(3946000.)	374

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TABLE X

TRANSITIONS - CARBON ISOELECTRONIC SEQUENCE

		C I	N II	O III	F IV	Ne V	Na VI	Mg VII
$2p^2 - 2s2p^3$	$^3P_2 - {}^3D^0_3$	1561.44	1085.70	835.29	679.22	572.34	494.38	434.92
$2p^2 - 2p(^2P^0)3s$	$^3P_2 - {}^3P^0_2$	1657.01	671.39	374.08	240.08	167.67	123.93	95.42
	$^1S_0 - {}^1P^0_1$	2479.31	858.38	434.98	270.22	184.73	134.53	102.47
$2p^2 - 2p(^2P^0)3d$	$^3P_2 - {}^3P^0_2$	1261.55	529.87	303.80	200.09	142.72	107.29	83.76
	$^3P_2 - {}^3D^0_3$	1277.55	533.73	305.77	201.16	143.34	107.68	84.02
	$^1S_0 - {}^1P^0_1$	1751.83	635.20	345.31	220.77	156.61	114.66	88.68
	$^1D_2 - {}^1D^0_2$	1481.76	582.16	328.45	213.85	151.42	112.95	87.72
	$^1D_2 - {}^1F^0_3$	1463.34	574.65	320.98	208.26	147.13	109.90	85.40
$2p(^2P^0)3s - 2p(^2P^0)3p$	$^3P^0_2 - {}^3S_1$	9661.08	5046.51	3341.70	2516.30	(2025.44)	(1694.77)	(1468.56)
	$^3P^0_2 - {}^3P_2$	9097.33	4631.84	3048.01	2299.00	(1849.39)	1550.58	1334.33
	$^3P^0_2 - {}^3D_3$	10694.17	5681.13	3760.95	2826.97	2307.34	(1900.96)	(1636.82)
	$^1P^0_1 - {}^1S_0$	8349.97	3438.13	2455.74	(1754.58)	(1364.83)		
	$^1P^0_1 - {}^1P_1$	14546.49	6483.84	5593.92	(4116.31)	(3314.66)		
	$^1P^0_1 - {}^1D_2$	9408.31	3961.60	2984.65	2172.13	(1716.18)	(1422.84)	
$2p(^2P^0)3p - 2p(^2P^0)3d$	$^3D_3 - {}^3F^0_4$	11756.53	5006.55	3266.40	2457.66	(2006.06)	(1721.88)	(1497.95)

Note: Transitions in Angstroms. ( ) indicates predictions.

TABLE X

TRANSITIONS - CARBON ISOELECTRONIC SEQUENCE (continued)

		Al VIII	Si IX	P X	S XI	Cl XII	Ar XIII	K XIV
$2p^2 - 2s2p^3$	$^3P_2 - {}^3D_3^0$	387.97	349.96	318.26	(297.09)	(276.68)	(260.32)	
$2p^2 - 2p(^2P^0)3s$	$^3P_2 - {}^3P_2^0$	75.78	61.65	51.15	(43.17)	(36.91)	(31.94)	
	$^1S_0 - {}^1P_1^0$	80.70	65.23	53.85	(45.21)	(38.74)	(33.42)	
$2p^2 - 2p(^2P^0)3d$	$^3P_2 - {}^3P_2^0$	67.29	55.27	46.23	(39.27)	(33.76)	(29.35)	
	$^3P_2 - {}^3D_3^0$	67.46	55.40	46.33	(39.38)	(33.87)	(29.45)	(25.86)
	$^1S_0 - {}^1P_1^0$	70.73	57.78	48.12	(40.68)	(35.04)	(30.37)	
	$^1D_2 - {}^1D_2^0$	70.16	57.43	47.90	(40.53)	(34.96)	(30.36)	(26.56)
	$^1D_2 - {}^1F_3^0$	68.38	56.03	46.77	(39.62)	(34.18)	(29.68)	(25.98)
$2p(^2P^0)3s - 2p(^2P^0)3p$	$^3P_2^0 - {}^3S_1$	1280.41	(1143.51)					
	$^3P_2^0 - {}^3P_2$	(1177.58)	(1070.09)					
	$^3P_2^0 - {}^3D_3$							
	$^1P_1^0 - {}^1S_0$							
	$^1P_1^0 - {}^1P_1$							
	$^1P_1^0 - {}^1D_2$							
$2p(^2P^0)3p - 2p(^2P^0)3d$	$^3D_3 - {}^3F_4^0$							

TABLE XI NITROGEN ISOELECTRONIC SEQUENCE

1S2 2S2 2P3( ) 2P* 1

N	1	7	28838.920	376
O	2	8	40468.4	487
F	3	9	51558.	487
NE	4	10	*62150.*	487
NA	5	11	*73221.*	487
MG	6	12	*83805.*	487
AL	7	13	*94380.*	487
SI	8	14	*103320.*	487
P	9	15	*113457.*	487
S	10	16	*122230.*	161
CL	11	17	*139950.*	161
AR	12	18	*147610.*	161
K	13	19	*159570.*	161T
CA	14	20	*171800.*	161T
SC	15	21	(179000.)	374
TI	16	22	(190000.)	374
V	17	23	(201000.)	374
CR	18	24	(211000.)	374

1S2 2S2 2P3( ) 2P* 2

N	1	7	28839.306	376
O	2	8	40466.9	487
F	3	9	51558.	487
NE	4	10	*62157.*	487
NA	5	11	*73260.*	487
MG	6	12	*83927.*	487
AL	7	13	*94650.*	487
SI	8	14	*103900.*	487
P	9	15	*114430.*	487
S	10	16	*124080.*	161
CL	11	17	*143000.*	161
AR	12	18	*152580.*	161
K	13	19	*166830.*	161T
CA	14	20	*182000.*	161T
SC	15	21	(191000.)	374
TI	16	22	(204000.)	374
V	17	23	(218000.)	374
CR	18	24	(231000.)	374

1S2 2S2 2P3( ) 2D* 2

N	1	7	19233.177	205
O	2	8	26829.4	487
F	3	9	34120.	487
NE	4	10	*40995.*	487
NA	5	11	*48362.*	487
MG	6	12	*55266.*	487
AL	7	13	*62080.*	487
SI	8	14	*67140.*	487
P	9	15	*73167.*	487
S	10	16	*77670.*	161
CL	11	17	*90760.*	161
AR	12	18	*93400.*	161
K	13	19	*100000.*	161
CA	14	20	*172320.*	269
CA	14	20	*106600.*	161T
SC	15	21	(114000.)	374
TI	16	22	(121000.)	374
V	17	23	(127000.)	374
CR	18	24	(134000.)	374

TABLE XI NITROGEN ISOELECTRONIC SEQUENCE (cont.)

1S2 2S2 2P3( ) 2D* 3

N	1	7	19224.464	205
O	2	8	26808.4	487
F	3	9	34084.	487
NE	4	10	*40950.*	487
NA	5	11	*48337.*	487
MG	6	12	*55245.*	487
AL	7	13	*62140.*	487
SI	8	14	*67420.*	487
P	9	15	*73730.*	487
S	10	16	*78800.*	161
CL	11	17	*92800.*	161
AR	12	18	*96750.*	161
K	13	19	*105430.*	161
CA	14	20	*180000.*	269
CA	14	20	*114780.*	161T
SC	15	21	(124000.)	374
TI	16	22	(133000.)	374
V	17	23	(142000.)	374
CR	18	24	(152000.)	374

1S2 2S 2P4( ) 2S 1

N	1	7	(144000.)	374
O	2	8	195710.4	487
F	3	9	248260.	487
NE	4	10	*299351.*	487
NA	5	11	*350754.*	487
MG	6	12	*401714.*	487
AL	7	13	*452740.*	487
SI	8	14	*502360.*	487
P	9	15	*552540.*	487
S	10	16	*604080.*	161
CL	11	17	*663670.*	161
AR	12	18	*713900.*	161
K	13	19	*769380.*	161T
CA	14	20	*825430.*	161T
SC	15	21	(866000.)	374
TI	16	22	(917000.)	374
V	17	23	(969000.)	374
CR	18	24	(1020000.)	374

1S2 2S 2P4( ) 4P 1

N	1	7	88170.54	EJ61
O	2	8	120083.5	487
F	3	9	152410.0	487
NE	4	10	184799.	487
NA	5	11	217440.	487
MG	6	12	250445.	487
AL	7	13	283960.	487
SI	8	14	318160.	487
P	9	15	353050.	487
S	10	16	388870.	161
CL	11	17	425830.	161
AR	12	18	464050.	161
K	13	19	503730.	269
CA	14	20	545080.	269
SC	15	21	(588400.)	374
TI	16	22	(633800.)	374
V	17	23	(681700.)	374
CR	18	24	(732300.)	374

TABLE XI NITROGEN ISOELECTRONIC SEQUENCE (cont.)

1S2 2S 2P4( ) 4P 2

N	1	7	88151.14	EJ61
O	2	8	120001.1	487
F	3	9	152235.3	487
NE	4	10	184477.	487
NA	5	11	216896.	487
MG	6	12	249578.	487
AL	7	13	282660.	487
SI	8	14	316260.	487
P	9	15	350440.	487
S	10	16	385320.	161
CL	11	17	421190.	161
AR	12	18	458110.	161
K	13	19	496350.	269
CA	14	20	535850.	269
SC	15	21	(577200.)	374
TI	16	22	(620300.)	374
V	17	23	(665600.)	374
CR	18	24	(713300.)	374

1S2 2S 2P4( ) 4P 3

N	1	7	88107.23	EJ61
O	2	8	119837.7	487
F	3	9	151897.9	487
NE	4	10	183860.	487
NA	5	11	215860.	487
MG	6	12	247945.	487
AL	7	13	280200.	487
SI	8	14	312670.	487
P	9	15	345390.	487
S	10	16	378450.	161
CL	11	17	411930.	161
AR	12	18	445940.	161
K	13	19	480520.	269
CA	14	20	515780.	269
SC	15	21	(551900.)	374
TI	16	22	(589000.)	374
V	17	23	(627100.)	374
CR	18	24	(666500.)	374

TABLE XII

TRANSITIONS - NITROGEN ISOELECTRONIC SEQUENCE

		N I	O II	F III	Ne IV	Na V	Mg VI	Al VII	Si VIII	P IX
$2s^2 2p - 2s2p^4$	${}^4S^0_{3/2} - {}^4P_{1/2}$	1134.17	832.75	656.12	541.13	459.90	399.29	352.16	314.31	283.25
	${}^4S^0_{3/2} - {}^4P_{3/2}$	1134.42	833.33	656.88	542.07	461.05	400.68	353.78	316.20	285.36
	${}^4S^0_{3/2} - {}^4P_{5/2}$	1134.98	834.46	658.34	543.89	463.26	403.32	356.89	319.83	289.53
	${}^2P^0_{1/2} - {}^2S_{1/2}$	(868.35)	644.16	508.38	421.58	360.32	314.55	279.05	250.60	227.75
	${}^2P^0_{3/2} - {}^2S_{1/2}$	(868.35)	644.15	508.38	421.59	360.37	314.67	279.26	250.97	228.25

		S X	Cl XI	Ar XII	K XIII	Ca XIV	Sc XV	Ti XVI	V XVII	Cr XVIII
$2s^2 2p - 2s2p^4$	${}^4S^0_{3/2} - {}^4P_{1/2}$	257.15	234.84	215.49	198.52	183.46	(169.95)	(157.78)	(146.69)	(136.56)
	${}^4S^0_{3/2} - {}^4P_{3/2}$	259.52	237.42	218.29	201.47	186.62	(173.25)	(161.25)	(150.24)	(140.19)
	${}^4S^0_{3/2} - {}^4P_{5/2}$	264.24	242.76	224.25	208.11	193.88	(181.19)	(169.78)	(159.46)	(150.04)
	${}^2P^0_{1/2} - {}^2S_{1/2}$	207.53	190.94	176.58	163.99	152.99	(145.56)	(137.55)	(130.21)	(123.61)
	${}^2P^0_{3/2} - {}^2S_{1/2}$	208.33	192.06	178.15	165.96	155.42	(148.15)	(140.25)	(133.16)	(126.74)

Note: Transitions in Angstroms. (   ) indicates prediction.

TABLE XIII OXYGEN ISOELECTRONIC SEQUENCE

1S2 2S2 2P4( ) G 3P 0

O	1	8	226.977	210
F	2	9	490.6	487
NE	3	10	922.	057
NA	4	11	1576.	487
MG	5	12	2519.	487
AL	6	13	3831.	487
SI	7	14	5570.	487
P	8	15	7826.	487
S	9	16	10630.	487
CL	10	17	14130.	160
AR	11	18	18280.	160
K	12	19	23240.	161
CA	13	20	28830.	269
CA	13	20	29053.	160
SC	14	21	(36200.)	374
TI	15	22	(44800.)	374
V	16	23	(54900.)	374
CR	17	24	(66700.)	374

1S2 2S2 2P4( ) G 3P 1

O	1	8	158.265	210
F	2	9	341.8	487
NE	3	10	642.9	487
NA	4	11	1106.	487
MG	5	12	1780.	487
AL	6	13	2736.	487
SI	7	14	4030.	487
P	8	15	5757.	487
S	9	16	7970.	487
CL	10	17	10880.	487
AR	11	18	14470.	160
K	12	19	18990.	161
CA	13	20	24410.	269
CA	13	20	24300.	160
SC	14	21	(31200.)	374
TI	15	22	(39300.)	374
V	16	23	(48900.)	374
CR	17	24	(60200.)	374

1S2 2S2 2P4( ) 1S 0

O	1	8	33792.583	210
F	2	9	44919.	487
NE	3	10	55747.	487
NA	4	11	*66492.*	487
MG	5	12	*77254.*	487
AL	6	13	*88210.*	487
SI	7	14	*99330.*	487
P	8	15	*110970.*	487
S	9	16	*122300.*	487
CL	10	17	*130310.*	487
AR	11	18	(143000.)	374
K	12	19	*138000.*	269
K	12	19	(154000.)	374
CA	13	20	*149135.*	269
CA	13	20	(165000.)	374
SC	14	21	(175000.)	374

TABLE XIII OXYGEN ISOELECTRONIC SEQUENCE (cont.)

1S2 2S2 2P4( ) 1D 2

O	1	8	15867.862	210
F	2	9	20873.	487
NE	3	10	25840.8	487
NA	4	11	*30830.*	487
MG	5	12	*35890.*	487
AL	6	13	*41140.*	487
SI	7	14	*46550.*	487
P	8	15	*52450.*	487
S	9	16	*58000.*	487
CL	10	17	*61000.*	487
CL	10	17	(62600.)	374
AR	11	18	*62730.*	160
AR	11	18	(67900.)	374
K	12	19	*80600.*	161
K	12	19	(73200.)	374
CA	13	20	*89353.*	160
CA	13	20	(78400.)	374

1S2 2S 2P5( ) 3P* 0

O	1	8	126383.751	210
F	2	9	165281.0	487
NE	3	10	205199.	057
NA	4	11	245238.	487
MG	5	12	285708.	487
AL	6	13	326822.	487
SI	7	14	368760.	487
P	8	15	411736.	487
S	9	16	455830.	372
CL	10	17	501510.	160
AR	11	18	549000.	160
K	12	19	598460.	161
CA	13	20	650120.	269
SC	14	21	(704700.)	374
TI	15	22	(762500.)	374
V	16	23	(823500.)	374
CR	17	24	(889000.)	374

1S2 2S 2P5( ) 3P* 1

O	1	8	126340.225	210
F	2	9	165107.1	487
NE	3	10	204876.	057
NA	4	11	244688.	487
MG	5	12	284827.	487
AL	6	13	325470.	487
SI	7	14	366780.	487
P	8	15	408913.	487
S	9	16	451930.	372
CL	10	17	496260.	160
AR	11	18	541960.	160
K	12	19	589230.	161
CA	13	20	638240.	269
SC	14	21	(689600.)	374
TI	15	22	(743500.)	374
V	16	23	(800000.)	374
CR	17	24	(860000.)	374

TABLE XIII OXYGEN ISOELECTRONIC SEQUENCE (cont.)

1S2 2S 2P5( ) 3P* 2

O	1	8	126266.896	210
F	2	9	164797.7	487
NE	3	10	204290.	057
NA	4	11	243682.	487
MG	5	12	283211.	487
AL	6	13	323002.	487
SI	7	14	363170.	487
P	8	15	403806.	487
S	9	16	444900.	372
CL	10	17	486850.	160
AR	11	18	529670.	160
K	12	19	573410.	161
CA	13	20	618240.	269
SC	14	21	(664700.)	374
TI	15	22	(713000.)	374
V	16	23	(763000.)	374
CR	17	24	(815000.)	374

1S2 2S 2P5( ) 1P* 1

O	1	8	189837.	487
F	2	9	239605.0	487
NE	3	10	289479.	487
NA	4	11	*343684.*	487
MG	5	12	*397448.*	487
AL	6	13	*451380.*	487
SI	7	14	*505630.*	487
P	8	15	*560680.*	487
S	9	16	*615820.*	372
CL	10	17	*668850.*	160
AR	11	18	*721220.*	160
K	12	19	*790500.*	161
CA	13	20	*851430.*	269
SC	14	21	(926000.)	374
TI	15	22	(1010000.)	374
V	16	23	(1107000.)	374
CR	17	24	(1221000.)	374

1S2 2S2 2P3(4S*) 3S 3S* 1

O	1	8	76794.978	210
F	2	9	182865.2	487
NE	3	10	319442.00	057
NA	4	11	486648.	487
MG	5	12	684544.	487
AL	6	13	913130.	487
SI	7	14	1172470.	487
P	8	15	1462340.	487
S	9	16	1783150.	487
CL	10	17	2134700.	487
AR	11	18	2516400.	255
K	12	19	(2929000.)	374
CA	13	20	(3373000.)	374
SC	14	21	(3847000.)	374
TI	15	22	(4351000.)	374

TABLE XIII OXYGEN ISOELECTRONIC SEQUENCE (cont.)

1S2 2S2 2P3(2P*) 3S 3P* 0

O	1	8	113927.534	210
F	2	9	229555.10	487
NE	3	10	374474.66	057
NA	4	11	550176.	487
MG	5	12	(756450.)	374
AL	6	13	(993600.)	374
SI	7	14	(1261400.)	374
P	8	15	1559500.	487
S	9	16	(1888000.)	374
CL	10	17	(2247000.)	374
AR	11	18	(2636000.)	374

1S2 2S2 2P3(2P*) 3S 3P* 1

O	1	8	113921.391	210
F	2	9	229552.44	487
NE	3	10	374457.75	057
NA	4	11	550176.	487
MG	5	12	756536.	487
AL	6	13	993660.	487
SI	7	14	1261610.	487
P	8	15	1560070.	487
S	9	16	(1889000.)	374
CL	10	17	(2248500.)	374
AR	11	18	(2638000.)	374

1S2 2S2 2P3(2P*) 3S 3P* 2

O	1	8	113910.957	210
F	2	9	229550.83	487
NE	3	10	374431.00	057
NA	4	11	550176.	487
MG	5	12	756589.	487
AL	6	13	993880.	487
SI	7	14	1262040.	487
P	8	15	1561260.	487
S	9	16	(1891000.)	374
CL	10	17	(2251000.)	374
AR	11	18	(2642000.)	374

1S2 2S2 2P3(2P*) 3S 1P* 1

O	1	8	115918.143	210
F	2	9	227228.2	487
NE	3	10	379834.	487
NA	4	11	*556793.*	487
MG	5	12	*764591.*	487
AL	6	13	*1003240.*	487
SI	7	14	*1272720.*	487
P	8	15	*1573270.*	487
S	9	16	*1904040.*	487
CL	10	17	*2262140.*	487
AR	11	18	(2653000.)	374
K	12	19	(3074000.)	374
CA	13	20	(3525000.)	374
SC	14	21	(4008000.)	374

TABLE XIII OXYGEN ISOELECTRONIC SEQUENCE (cont.)

1S2 2S2 2P3(2D*) 3S 3D* 1

O	1	8	101155.422	210
F	2	9	211900.72	487
NE	3	10	353194.40	057
NA	4	11	525136.	487
MG	5	12	727787.	487
AL	6	13	961100.	487
SI	7	14	1225150.	487
P	8	15	1519740.	487
S	9	16	(1846720.)	375
CL	10	17	2202610.	487
AR	11	18	(2589000.)	374
K	12	19	(3007000.)	374
CA	13	20	(3455000.)	374

1S2 2S2 2P3(2D*) 3S 3D* 2

O	1	8	101147.526	210
F	2	9	211887.69	487
NE	3	10	353174.16	057
NA	4	11	525119.	487
MG	5	12	727763.	487
AL	6	13	961100.	487
SI	7	14	1225150.	487
P	8	15	1519740.	487
S	9	16	1846340.	487
CL	10	17	2202610.	487
AR	11	18	(2589000.)	374
K	12	19	(3007000.)	374
CA	13	20	(3455000.)	374

1S2 2S2 2P3(2D*) 3S 3D* 3

O	1	8	101135.407	210
F	2	9	211866.62	487
NE	3	10	353145.	057
NA	4	11	525100.	487
MG	5	12	727718.	487
AL	6	13	961100.	487
SI	7	14	1225150.	487
P	8	15	1520030.	487
S	9	16	1845770.	487
CL	10	17	2202610.	487
AR	11	18	(2589000.)	374
K	12	19	(3007000.)	374
CA	13	20	(3455000.)	374

1S2 2S2 2P3(2D*) 3S 1D* 2

O	1	8	102662.026	210
F	2	9	215069.8	487
NE	3	10	357930.	487
NA	4	11	*531408.*	487
MG	5	12	*735518.*	487
AL	6	13	*970330.*	487
SI	7	14	*1235870.*	487
P	8	15	*1532020.*	487
S	9	16	*1858500.*	487
CL	10	17	*2212650.*	487
AR	11	18	*2594300.*	255
K	12	19	(3013000.)	374
CA	13	20	(3459000.)	374
SC	14	21	(3936000.)	374

TABLE XIII OXYGEN ISOELECTRONIC SEQUENCE (cont.)

1S2 2S2 2P3(2D*) 3D 3S* 1

O	1	8	(123900.)	374
F	2	9	266360.69	487
NE	3	10	440064.90	487
NA	4	11	644140.	487
MG	5	12	879485.	487
AL	6	13	1145020.	487
SI	7	14	1441230.	487
P	8	15	1767880.	487
S	9	16	2125310.	487
CL	10	17	(2513000.)	374
AR	11	18	(2933000.)	374
K	12	19	(3383000.)	374

1S2 2S2 2P3(2P*) 3D 3P* 0

O	1	8	(138400.)	374
F	2	9	282897.0	487
NE	3	10	(457800.)	374
NA	4	11	663592.	487
MG	5	12	898673.	487
AL	6	13	1164220.	487
SI	7	14	1460290.	487
P	8	15	1787090.	487
S	9	16	(2143800.)	374
CL	10	17	(2531000.)	374
AR	11	18	(2948000.)	374

1S2 2S2 2P3(2P*) 3D 3P* 1

O	1	8	(138400.)	374
F	2	9	282913.4	487
NE	3	10	(457800.)	374
NA	4	11	663592.	487
MG	5	12	898904.	487
AL	6	13	1164620.	487
SI	7	14	1460860.	487
P	8	15	1788090.	487
S	9	16	2144820.	487
CL	10	17	(2532500.)	374
AR	11	18	(2950000.)	374

1S2 2S2 2P3(2P*) 3D 3P* 2

O	1	8	(138400.)	374
F	2	9	282947.9	487
NE	3	10	(457800.)	374
NA	4	11	663592.	487
MG	5	12	899291.	487
AL	6	13	1165260.	487
SI	7	14	1461860.	487
P	8	15	1789690.	487
S	9	16	2146610.	487
CL	10	17	(2535000.)	374
AR	11	18	(2953000.)	374

TABLE XIII OXYGEN ISOELECTRONIC SEQUENCE (cont.)

1S2 2S2 2P3(2P*) 3D 1P* 1

O	1	8	(140000.)	374
F	2	9	284224.8	487
NE	3	10	(459200.)	374
NA	4	11	*665352.*	487
MG	5	12	*902449.*	487
AL	6	13	*1170590.*	487
SI	7	14	*1470040.*	487
P	8	15	*1800760.*	487
S	9	16	*2162470.*	487
CL	10	17	(2555000.)	374
AR	11	18	(2979000.)	374

1S2 2S2 2P3(2D*) 3D 3P* 0

O	1	8	123387.339	210
F	2	9	266516.35	487
NE	3	10	439760.35	487
NA	4	11	643396.	487
MG	5	12	877444.	487
AL	6	13	1141910.	487
SI	7	14	1437090.	487
P	8	15	(1763000.)	374
S	9	16	(2120000.)	374
CL	10	17	(2507000.)	374
AR	11	18	(2927000.)	374
K	12	19	(3377000.)	374

1S2 2S2 2P3(2D*) 3D 3P* 1

O	1	8	123355.512	210
F	2	9	266499.12	487
NE	3	10	439707.81	487
NA	4	11	643304.	487
MG	5	12	877244.	487
AL	6	13	1141670.	487
SI	7	14	1436750.	487
P	8	15	1762400.	487
S	9	16	2119180.	487
CL	10	17	(2506000.)	374
AR	11	18	(2925000.)	374
K	12	19	(3375000.)	374

1S2 2S2 2P3(2D*) 3D 3P* 2

O	1	8	123296.777	210
F	2	9	266454.27	487
NE	3	10	439586.00	487
NA	4	11	643029.	487
MG	5	12	876762.	487
AL	6	13	1140840.	487
SI	7	14	1435460.	487
P	8	15	1760530.	487
S	9	16	2116450.	487
CL	10	17	2502750.	487
AR	11	18	2920600.	255
K	12	19	(3369000.)	374

TABLE XIII OXYGEN ISOELECTRONIC SEQUENCE (cont.)

1S2 2S2 2P3(2D*) 3D 1P* 1

O	1	8	(126000.)	374
F	2	9	267400.3	487
NE	3	10	(439000.)	374
NA	4	11	*641180.*	487
MG	5	12	*873404.*	487
AL	6	13	*1136040.*	487
SI	7	14	*1429230.*	487
P	8	15	*1753830.*	487
S	9	16	(2111000.)	374
CL	10	17	(2501000.)	374

1S2 2S2 2P3(4S*) 3D 3D* 1

O	1	8	97488.378	210
F	2	9	232064.18	487
NE	3	10	398189.80	057
NA	4	11	594893.	487
MG	5	12	821963.	487
AL	6	13	1079460.	487
SI	7	14	1367360.	487
P	8	15	1685980.	487
S	9	16	2035220.	487
CL	10	17	2415000.	374
AR	11	18	2843300.	255
K	12	19	(3301000.)	374
CA	13	20	(3798000.)	374

1S2 2S2 2P3(4S*) 3D 3D* 2

O	1	8	97488.431	210
F	2	9	232064.98	487
NE	3	10	398193.93	057
NA	4	11	594898.	487
MG	5	12	821977.	487
AL	6	13	1079490.	487
SI	7	14	1367460.	487
P	8	15	1685980.	487
S	9	16	2035220.	487
CL	10	17	2415360.	487
AR	11	18	2838900.	255
K	12	19	(3301000.)	374
CA	13	20	(3798000.)	374

1S2 2S2 2P3(4S*) 3D 3D* 3

O	1	8	97488.523	210
F	2	9	232067.06	487
NE	3	10	398207.84	057
NA	4	11	594941.	487
MG	5	12	822071.	487
AL	6	13	1079610.	487
SI	7	14	1367560.	487
P	8	15	1686280.	487
S	9	16	2035870.	487
CL	10	17	2416040.	487
AR	11	18	2825700.	255
K	12	19	(3301000.)	374
CA	13	20	(3798000.)	374

TABLE XIII OXYGEN ISOELECTRONIC SEQUENCE (cont.)

1S2 2S2 2P3(2P*) 3D 3D* 1

O	1	8	(150000.)	374
F	2	9	(288000.)	374
NE	3	10	(460000.)	374
NA	4	11	665362.	487
MG	5	12	902682.	487
AL	6	13	(1171000.)	374
SI	7	14	(1471000.)	374
P	8	15	(1802000.)	374
S	9	16	(2166000.)	374
CL	10	17	(2564000.)	374
AR	11	18	(2994000.)	374

1S2 2S2 2P3(2P*) 3D 3D* 2

O	1	8	(150000.)	374
F	2	9	(288000.)	374
NE	3	10	(460000.)	374
NA	4	11	665362.	487
MG	5	12	902441.	487
AL	6	13	1170650.	487
SI	7	14	1470050.	487
P	8	15	1800770.	487
S	9	16	(2163000.)	374
CL	10	17	(2558000.)	374
AR	11	18	(2987000.)	374

1S2 2S2 2P3(2P*) 3D 3D* 3

O	1	8	(150000.)	374
F	2	9	(288000.)	374
NE	3	10	(460000.)	374
NA	4	11	665362.	487
MG	5	12	902047.	487
AL	6	13	1169390.	487
SI	7	14	1467390.	487
P	8	15	1796240.	487
S	9	16	2156430.	487
CL	10	17	2547580.	487
AR	11	18	(2974000.)	374

1S2 2S2 2P3(2P*) 3D 1D* 2

O	1	8	(140000.)	374
F	2	9	282774.7	487
NE	3	10	(458000.)	374
NA	4	11	*664616.*	487
MG	5	12	*901414.*	487
AL	6	13	*1168690.*	487
SI	7	14	*1466460.*	487
P	8	15	*1795430.*	487
S	9	16	(2154000.)	374
CL	10	17	(2544000.)	374
AR	11	18	(2964000.)	374

1S2 2S2 2P3(2D*) 3D 3D* 1

O	1	8	(124000.)	374
F	2	9	265517.14	487
NE	3	10	436963.49	057
NA	4	11	638977.	487
MG	5	12	871221.	487
AL	6	13	1134170.	487
P	8	15	1753090.	487
S	9	16	2108190.	487
CL	10	17	2494700.	487
AR	11	18	2928800.	255
K	12	19	(3359000.)	374
CA	13	20	(3837000.)	374
SC	14	21	(4346000.)	374

1S2 2S2 2P3(2D*) 3D 3D* 2

O	1	8	(124000.)	374
F	2	9	265498.74	487
NE	3	10	436918.39	057
NA	4	11	638942.	487
MG	5	12	871221.	487
AL	6	13	1134170.	487
SI	7	14	1428090.	487
P	8	15	1753090.	487
S	9	16	2108190.	487
CL	10	17	2494700.	487
AR	11	18	2924400.	255
K	12	19	(3359000.)	374
CA	13	20	(3837000.)	374
SC	14	21	(4346000.)	374

1S2 2S2 2P3(2D*) 3D 3D* 3

O	1	8	(124000.)	374
F	2	9	265472.70	487
NE	3	10	436841.63	057
NA	4	11	638831.	487
MG	5	12	871221.	487
AL	6	13	1134170.	487
SI	7	14	1428020.	487
P	8	15	1753090.	487
S	9	16	2108190.	487
CL	10	17	2494700.	487
AR	11	18	2911200.	255
K	12	19	(3359000.)	374
CA	13	20	(3837000.)	374
SC	14	21	(4346000.)	374

TABLE XIII OXYGEN ISOELECTRONIC SEQUENCE (cont.)

1S2 2S2 2P3(2D*) 3D 1D* 2

O	1	8	124319.175	210
F	2	9	266270.2	487
NE	3	10	(440000.)	374
NA	4	11	*643624.*	487
MG	5	12	*877570.*	487
AL	6	13	*1141760.*	487
SI	7	14	*1436310.*	487
P	8	15	*1761680.*	487
S	9	16	*2117140.*	487
CL	10	17	*2500380.*	487
AR	11	18	(2917000.)	374
K	12	19	(3363000.)	374
CA	13	20	(3841000.)	374
SC	14	21	(4350000.)	374

1S2 2S2 2P3(2D*) 3D 3F* 2

O	1	8	124224.118	210
F	2	9	264953.12	487
NE	3	10	435522.9	057
NA	4	11	(637000.)	374
MG	5	12	(869000.)	374
AL	6	13	1132180.	487
SI	7	14	1426050.	487
P	8	15	1749870.	487
S	9	16	(2105000.)	374
CL	10	17	(2490000.)	374
AR	11	18	(2910000.)	374
K	12	19	(3353000.)	374

1S2 2S2 2P3(2D*) 3D 3F* 3

O	1	8	124219.025	210
F	2	9	264958.63	487
NE	3	10	435569.0	057
NA	4	11	(637000.)	374
MG	5	12	(869000.)	374
AL	6	13	1132180.	487
SI	7	14	1426050.	487
P	8	15	1749870.	487
S	9	16	(2105000.)	374
CL	10	17	(2490000.)	374
AR	11	18	(2910000.)	374
K	12	19	(3353000.)	374

1S2 2S2 2P3(2D*) 3D 3F* 4

O	1	8	124213.18	487
O	1	8	124213.607	210
F	2	9	264965.91	487
NE	3	10	435617.8	057
NA	4	11	(637000.)	374
MG	5	12	(869000.)	374
SI	7	14	1426050.	487
P	8	15	1749870.	487
S	9	16	(2105000.)	374
CL	10	17	(2490000.)	374
AR	11	18	(2910000.)	374
K	12	19	(3353000.)	374

1S2 2S2 2P3(2D*) 3D 1F* 3

O	1	8	124326.779	210
F	2	9	266548.7	487
NE	3	10	(442000.)	374
NA	4	11	*646423.*	487
MG	5	12	*882752.*	487
AL	6	13	*1149790.*	487
SI	7	14	*1447420.*	487
P	8	15	*1776050.*	487
S	9	16	*2134410.*	487
CL	10	17	*2520420.*	487
AR	11	18	(2942000.)	374
K	12	19	(3392000.)	374

1S2 2S2 2P3(2P*) 3D 1F* 3

O	1	8	(138000.)	374
F	2	9	283409.4	487
NE	3	10	(460000.)	374
NA	4	11	*667408.*	487
MG	5	12	*904753.*	487
AL	6	13	*1173990.*	487
SI	7	14	*1473650.*	487
P	8	15	*1804930.*	487
S	9	16	(2166000.)	374
CL	10	17	(2559000.)	374
AR	11	18	(2983000.)	374

1S2 2S2 2P3(4S*) 4S 3S* 1

O	1	8	96225.049	210
F	2	9	236961.63	487
NE	3	10	(420000.)	374
NA	4	11	644792.	487
MG	5	12	910639.	487
AL	6	13	1218290.	487
SI	7	14	(1567300.)	374
P	8	15	1958370.	487
S	9	16	(2392300.)	374
CL	10	17	(2870000.)	374

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TABLE XIV

TRANSITIONS - OXYGEN ISOELECTRONIC SEQUENCE

		O I	F II	Ne III	Na IV	Mg V	Al VI	Si VII	P VIII	S IX
$2p^4 - 2p^3(^2D^o)3s$	$^3P_2 - ^3D^o_3$	988.77	472.00	283.17	190.44	137.42	104.05	81.62	65.79	54.18
	$^1D_2 - ^1D^o_2$	1152.15	514.94	301.12	199.76	142.93	107.62	84.08	67.59	55.54
$2p^4 - 2p^3(^2D^o)3d$	$^3P_2 - ^3S^o_1$	(807.10)	375.43	227.24	155.26	113.70	87.33	69.39	56.56	47.05
	$^3P_2 - ^3D^o_3$	(806.45)	376.69	228.92	156.54	114.78	88.17	70.03	57.04	47.43
	$^1S_0 - ^1P^o_1$	(1084.51)	449.48	(260.92)	174.01	125.60	95.43	75.19	60.87	(50.28)
	$^1D_2 - ^1P^o_1$	(908.00)	405.63	(242.04)	163.84	119.40	91.33	72.32	58.77	(48.71)
	$^1D_2 - ^1D^o_2$		407.50	(241.53)	163.19	118.81	90.86	71.95	58.51	48.56
	$^1D_2 - ^1F^o_3$		407.04	(240.29)	162.44	118.08	90.20	71.38	58.02	48.16
$2p^4 - 2p^3(^4S^o)3d$	$^3P_2 - ^3D^o_3$	1025.76	430.91	251.13	168.08	121.64	92.63	73.12	59.30	49.12
$2p^4 - 2p^3(^4S^o)4s$	$^3P_2 - ^3S^o_1$	1039.23	422.01	(238.10)	155.09	109.81	82.08	(63.80)	51.06	(41.80)
$2p^4 - 2s2p^5$	$^1S_0 - ^1P^o_1$	640.84	513.65	427.84	360.76	312.31	275.35	246.12	222.37	202.63
	$^1D_2 - ^1P^o_1$	574.81	457.81	379.30	319.64	276.58	243.76	217.83	196.76	179.27
$2p^4 - 2p^3(^4S^o)3s$	$^3P_2 - ^3S^o_1$	1302.17	546.85	313.05	205.49	146.08	109.51	85.29	68.38	56.08
$2p^4 - 2p^3(^2P^o)3s$	$^1S_0 - ^1P^o_1$	1217.65	548.52	308.56	203.96	145.49	109.29	85.22	68.39	56.12
	$^1D_2 - ^1P^o_1$	999.45	484.60	282.49	190.13	137.13	103.94	81.55	65.75	54.17
$2p^4 - 2p^3(^2P^o)3d$	$^3P_2 - ^3D^o_3$	(666.67)	(347.22)	(217.39)	150.29	110.89	85.51	68.15	55.67	46.37
	$^1D_2 - ^1D^o_2$	(805.59)	381.82	(231.40)	157.78	115.54	88.69	70.43	57.37	(47.71)
	$^1D_2 - ^1F^o_3$	(818.79)	380.90	(230.33)	157.09	115.09	88.27	70.07	57.06	(47.44)

Note: Transitions in Angstroms. (   ) indicates prediction.

TABLE XIV

TRANSITIONS - OXYGEN ISOELECTRONIC SEQUENCE (continued)

Transition	Term	Cl X	Ar XI	K XII	Ca XIII	Sc XIV	Ti XV	V XVI	Cr XVII
$2p^4 - 2p^3(^2D^o)3s$	$^3P_2 - ^3D^o_3$	45.40	(38.62)	(33.25)	(28.94)				
	$^1D_2 - ^1D^o_2$	46.48	(39.58)	(34.10)	(29.58)				
$2p^4 - 2p^3(^2D^o)3d$	$^3P_2 - ^3S^o_1$	(39.79)	(34.09)	(29.56)					
	$^3P_2 - ^3D^o_3$	40.08	35.35	(29.77)	(26.06)				
	$^1S_0 - ^1P^o_1$	(42.18)							
	$^1D_2 - ^1P^o_1$	(41.01)							
	$^1D_2 - ^1D^o_2$	(41.02)	(35.10)	(30.47)	(26.57)				
	$^1D_2 - ^1F^o_3$	(41.20)	(34.79)	(30.19)					
$2p^4 - 2p^3(^4S^o)3d$	$^3P_2 - ^3D^o_3$	41.39	35.39	(30.30)	(26.33)				
$2p^4 - 2p^3(^4S^o)4s$	$^3P_2 - ^3S^o_1$	(34.84)							
$2p^4 - 2s2p^5$	$^1S_0 - ^1P^o_1$	185.69	(172.94)	(157.11)	(145.68)	(133.16)			
	$^1D_2 - ^1P^o_1$	(164.95)	(153.06)	(139.41)	(129.36)				
$2p^4 - 2p^3(^4S^o)3s$	$^3P_2 - ^3S^o_1$	46.84	39.74	(34.14)	(29.65)	(25.99)	(22.98)		
$2p^4 - 2p^3(^2P^o)3s$	$^1S_0 - ^1P^o_1$	46.90	(39.84)	(34.05)	(29.76)	(26.09)			
	$^1D_2 - ^1P^o_1$	(45.46)	(38.68)	(33.41)	(29.11)				
$2p^4 - 2p^3(^2P^o)3d$	$^3P_2 - ^3D^o_3$	39.25	(33.62)						
	$^1D_2 - ^1D^o_2$	(40.30)	(34.47)						
	$^1D_2 - ^1F^o_3$	(40.05)	(34.30)						

TABLE XV FLUORINE ISOELECTRONIC SEQUENCE

1S2 2S2 2P5( ) G 2P* 1

F	1	9	404.10	420
NE	2	10	782.	PM68
NA	3	11	1364.	487
MG	4	12	2226.	487
AL	5	13	3440.	487
SI	6	14	5100.	487
P	7	15	7268.	487
S	8	16	(10110.)	375
CL	9	17	13600.	487
AR	10	18	(18110.)	375
K	11	19	23480.	269
CA	12	20	29940.	269
SC	13	21	(37700.)	375
TI	14	22	46800.	269
V	15	23	(57300.)	374
CR	16	24	(69600.)	374
MN	17	25	(83600.)	374
FE	18	26	(99700.)	374
CO	19	27	(118000.)	374
NI	20	28	(138000.)	374
CU	21	29	(161000.)	374
ZN	22	30	(187000.)	374

1S2 2S 2P6( ) 2S 1

F	1	9	169824.50	420
NE	2	10	217050.	487
NA	3	11	264449.	487
MG	4	12	311527.	487
AL	5	13	358810.	487
SI	6	14	406500.	487
P	7	15	454732.	487
S	8	16	503650.	598
CL	9	17	553400.	487
AR	10	18	603970.	255
K	11	19	655940.	269
CA	12	20	708970.	269
SC	13	21	763590.	269
TI	14	22	819600.	269
V	15	23	(877300.)	375
CR	16	24	(936700.)	375
MN	17	25	(998000.)	375
FE	18	26	(1061000.)	375
CO	19	27	(1126000.)	375
NI	20	28	(1195000.)	374
CU	21	29	(1265000.)	374
ZN	22	30	(1337000.)	374

TABLE XV FLUORINE ISOELECTRONIC SEQUENCE (cont.)

1S2 2S2 2P4(1S) 3S 2S 1

F	1	9	148984.	420
NE	2	10	276679.49	PM68
NA	3	11	435031.	487
MG	4	12	624102.	487
AL	5	13	843880.	487
SI	6	14	1094460.	487
P	7	15	1375810.	487
S	8	16	1688170.	487
CL	9	17	2031080.	487
AR	10	18	2406200.	255
K	11	19	(2795000.)	374
CA	12	20	(3220000.)	374
SC	13	21	(3673000.)	374

1S2 2S2 2P4(3P) 3S 4P 1

F	1	9	102840.38	420
NE	2	10	219949.77	PM68
NA	3	11	367561.9	487
MG	4	12	545962.1	487
AL	5	13	755250.	487
SI	6	14	(995700.)	374
P	7	15	*1266000.*	487
S	8	16	1569290.	487
CL	9	17	1901850.	487
AR	10	18	(2266000.)	374
K	11	19	(2661000.)	374
CA	12	20	(3086000.)	374
SC	13	21	(3543000.)	374
TI	14	22	(4030000.)	374
V	15	23	(4548000.)	374
CR	16	24	(5092000.)	374
MN	17	25	(5665000.)	374
FE	18	26	(6271000.)	374
CO	19	27	(6910000.)	374
NI	20	28	(7580000.)	374
CU	21	29	(8270000.)	374
ZN	22	30	(9000000.)	374

1S2 2S2 2P4(3P) 3S 4P 2

F	1	9	102680.44	420
NE	2	10	219650.76	PM68
NA	3	11	367052.3	487
MG	4	12	545143.5	487
AL	5	13	753960.	487
SI	6	14	993640.	487
P	7	15	1264170.	487
S	8	16	1565250.	487
CL	9	17	1896600.	487
AR	10	18	2259400.	255
K	11	19	*2652800.*	487
CA	12	20	3077100.	487
SC	13	21	3531000.	143
TI	14	22	4014000.	143
V	15	23	4527000.	143
CR	16	24	5071000.	143
MN	17	25	5643000.	143
FE	18	26	6246000.	143
CO	19	27	6882000.	143
NI	20	28	7553000.	143
CU	21	29	8244000.	143
ZN	22	30	(8972000.)	374

TABLE XV FLUORINE ISOELECTRONIC SEQUENCE (cont.)

1S2 2S2 2P4(3P) 3S 4P 3

F	1	9	102405.71	420
NE	2	10	219133.10	PM68
NA	3	11	366165.3	487
MG	4	12	543727.0	487
AL	5	13	751810.	487
SI	6	14	990460.	487
P	7	15	1259730.	487
S	8	16	1559580.	487
CL	9	17	1888970.	487
AR	10	18	2247700.	255
K	11	19	*2640600.*	487
CA	12	20	3062300.	487
SC	13	21	3515000.	143
TI	14	22	3995000.	143
V	15	23	4504000.	143
CR	16	24	5045000.	143
MN	17	25	5617000.	143
FE	18	26	6215000.	143
CO	19	27	6854000.	143
NI	20	28	7519000.	143
CU	21	29	8210000.	143
ZN	22	30	(8937000.)	374

1S2 2S2 2P4(3P) 3S 2P 1

F	1	9	105056.28	420
NE	2	10	224701.57	PM68
NA	3	11	374681.4	487
MG	4	12	555338.	487
AL	5	13	766790.	487
SI	6	14	1009140.	487
P	7	15	1282550.	487
S	8	16	1586650.	487
CL	9	17	1921050.	487
AR	10	18	2287300.	255
K	11	19	(2685000.)	374
CA	12	20	(3114000.)	374
SC	13	21	3575000.	143
TI	14	22	(4066000.)	374
V	15	23	(4589000.)	374
CR	16	24	*5139000.*	143
MN	17	25	(5730000.)	374
FE	18	26	(6346000.)	375
CO	19	27	(6995000.)	374
NI	20	28	(7675000.)	374
CU	21	29	(8386000.)	374
ZN	22	30	(9128000.)	374

TABLE XV FLUORINE ISOELECTRONIC SEQUENCE (cont.)

1S2 2S2 2P4(3P) 3S 2P 2

F	1	9	104731.05	420
NE	2	10	224089.34	PM68
NA	3	11	373633.0	487
MG	4	12	553659.	487
AL	5	13	764240.	487
SI	6	14	1005440.	487
P	7	15	1277380.	487
S	8	16	1579700.	487
CL	9	17	1911950.	487
AR	10	18	2276300.	255
K	11	19	*2671300.*	487
CA	12	20	3097900.	487
SC	13	21	3555000.	143
TI	14	22	4044000.	143
V	15	23	4562000.	143
CR	16	24	5115000.	143
MN	17	25	5685000.	267
FE	18	26	6297000.	143
CO	19	27	6935000.	143
NI	20	28	7610000.	143
CU	21	29	(8307000.)	374
ZN	22	30	(9036000.)	374

1S2 2S2 2P4(3P) 3P 4S* 2

F	1	9	118427.82	420
NE	2	10	252955.87	PM68
NA	3	11	417415.5	487
MG	4	12	612240.3	487
AL	5	13	(837100.)	374
SI	6	14	(1092000.)	374
P	7	15	(1377000.)	374

1S2 2S2 2P4(3P) 3P 2S* 1

F	1	9	118405.27	420
NE	2	10	252800.79	PM68
NA	3	11	416910.2	487
MG	4	12	(610700.)	374
AL	5	13	(834300.)	374
SI	6	14	(1088000.)	374
P	7	15	(1370000.)	374

1S2 2S2 2P4(1D) 3D 2S 1

F	1	9	(149000.)	374
NE	2	10	306013.36	PM68
NA	3	11	497751.2	487
MG	4	12	714330.	487
AL	5	13	960860.	487
SI	6	14	1241060.	487
P	7	15	1555560.	487
S	8	16	1894330.	487
CL	9	17	(2265000.)	374
AR	10	18	2660030.	259
K	11	19	(3099000.)	374
CA	12	20	(3563000.)	374
SC	13	21	4056000.	143
TI	14	22	*4531000.*	143
V	15	23	*5136000.*	143
CR	16	24	*5745000.*	143
MN	17	25	*6340000.*	143
FE	18	26	*6974000.*	143

TABLE XV FLUORINE ISOELECTRONIC SEQUENCE (cont.)

1S2 2S2 2P4(3P) 3D 4P 1

F	1	9	128338.72	420
NE	2	10	280770.84	PM68
NA	3	11	462391.2	487
MG	4	12	(677000.)	374
AL	5	13	921440.	487
SI	6	14	1194970.	487
P	7	15	(1501000.)	374
S	8	16	1835000.	487
CL	9	17	(2200000.)	374
AR	10	18	(2598000.)	374

1S2 2S2 2P4(3P) 3D 4P 2

F	1	9	128523.28	420
NE	2	10	280991.85	PM68
NA	3	11	462963.6	487
MG	4	12	677805.	487
AL	5	13	922120.	487
SI	6	14	1196040.	487
P	7	15	1500040.	487
S	8	16	1834830.	487
CL	9	17	(2200000.)	374
AR	10	18	(2598000.)	374

1S2 2S2 2P4(3P) 3D 4P 3

F	1	9	128606.09	420
NE	2	10	281173.72	PM68
NA	3	11	463257.4	487
MG	4	12	676837.	487
AL	5	13	922640.	487
SI	6	14	1197230.	487
P	7	15	1496890.	487
S	8	16	1838740.	487
CL	9	17	(2217000.)	374
AR	10	18	(2642000.)	374

1S2 2S2 2P4(3P) 3D 2P 1

F	1	9	128520.22	420
NE	2	10	281334.87	PM68
NA	3	11	465988.0	487
MG	4	12	681024.	487
AL	5	13	925900.	487
SI	6	14	1200720.	487
P	7	15	1505300.	487
S	8	16	1839250.	487
CL	9	17	(2205000.)	374
AR	10	18	(2601000.)	374
K	11	19	(3027000.)	374
CA	12	20	(3484000.)	374
SC	13	21	3970000.	143
TI	14	22	4488000.	143
V	15	23	5042000.	143
CR	16	24	5619000.	143
MN	17	25	6229000.	143
FE	18	26	*6870000.*	143
CO	19	27	(7510000.)	374
NI	20	28	*8297000.*	143

TABLE XV FLUORINE ISOELECTRONIC SEQUENCE (cont.)

1S2 2S2 2P4(3P) 3D 2P 2

F	1	9	128712.30	420
NE	2	10	281722.62	PM68
NA	3	11	466773.0	487
MG	4	12	682471.	487
AL	5	13	928410.	487
SI	6	14	1204740.	487
P	7	15	1511310.	487
S	8	16	1847550.	487
CL	9	17	(2212000.)	374
AR	10	18	(2609000.)	374
K	11	19	(3037000.)	374
CA	12	20	(3495000.)	374
SC	13	21	3981000.	143
TI	14	22	4503000.	143
V	15	23	5055000.	143
CR	16	24	5636000.	143
MN	17	25	*6257000.*	143
FE	18	26	6908000.	143
CO	19	27	7556000.	143
NI	20	28	8274000.	143
CU	21	29	9011000.	143

1S2 2S2 2P4(1D) 3D 2P 1

F	1	9	150000.	374
NE	2	10	305584.57	PM68
NA	3	11	493191.3	487
MG	4	12	711622.	487
AL	5	13	960420.	487
SI	6	14	1239200.	487
P	7	15	1548480.	487
S	8	16	1888460.	487
CL	9	17	(2257000.)	374
AR	10	18	(2659000.)	374
K	11	19	(3093000.)	374
CA	12	20	(3558000.)	374
SC	13	21	4057000.	143
TI	14	22	4583000.	143
V	15	23	5141000.	143
CR	16	24	5727000.	143
MN	17	25	6353000.	143
FE	18	26	7013000.	143
CO	19	27	7698000.	143
NI	20	28	8396000.	143
CU	21	29	(9142000.)	374
ZN	22	30	(9911000.)	374

TABLE XV FLUORINE ISOELECTRONIC SEQUENCE (cont.)

1S2 2S2 2P4(1D) 3D 2P 2

F	1	9	(150000.)	374
NE	2	10	305569.23	PM68
NA	3	11	493289.3	487
MG	4	12	711865.	487
AL	5	13	961630.	487
SI	6	14	1242390.	487
P	7	15	1552170.	487
S	8	16	1897460.	487
CL	9	17	(2267000.)	374
AR	10	18	(2671000.)	374
K	11	19	(3107000.)	374
CA	12	20	(3573000.)	374
SC	13	21	4072000.	143
TI	14	22	4602000.	143
V	15	23	5160000.	143
CR	16	24	5754000.	143
MN	17	25	6382000.	143
FE	18	26	7042000.	143
CO	19	27	7728000.	143
NI	20	28	8446000.	143
CU	21	29	(9200000.)	374
ZN	22	30	(9984000.)	374

1S2 2S2 2P4(3P) 3D 4D 1

F	1	9	128184.99	420
NE	2	10	279425.22	PM68
NA	3	11	460759.3	487
MG	4	12	677365.3	710
AL	5	13	920680.	487
SI	6	14	(1192000.)	374
P	7	15	(1496000.)	374
S	8	16	1822510.	487
CL	9	17	(2196000.)	374
AR	10	18	(2591000.)	374
K	11	19	(3020000.)	374
CA	12	20	(3500000.)	374

1S2 2S2 2P4(3P) 3D 4D 2

F	1	9	128122.72	420
NE	2	10	279327.24	PM68
NA	3	11	460605.6	487
MG	4	12	677365.3	710
AL	5	13	920680.	487
SI	6	14	(1192000.)	374
P	7	15	(1496000.)	374
S	8	16	1822510.	487
CL	9	17	(2196000.)	374
AR	10	18	(2591000.)	374
K	11	19	(3020000.)	374
CA	12	20	(3500000.)	374
SC	13	21	3964000.	143
TI	14	22	4480000.	143
V	15	23	5023000.	143
CR	16	24	5599000.	143
MN	17	25	6207000.	143
FE	18	26	6849000.	143
CO	19	27	(7520000.)	374
NI	20	28	8224000.	143
CU	21	29	8955000.	143

TABLE XV FLUORINE ISOELECTRONIC SEQUENCE (cont.)

1S2 2S2 2P4(3P) 3D 4D 3

F	1	9	128087.83	420
NE	2	10	279221.00	PM68
NA	3	11	460421.0	487
MG	4	12	676827.8	710
AL	5	13	919900.	487
SI	6	14	(1192000.)	374
P	7	15	(1496000.)	374
S	8	16	1831370.	487
CL	9	17	(2196000.)	374
AR	10	18	(2591000.)	374
K	11	19	(3020000.)	374
CA	12	20	(3500000.)	374

1S2 2S2 2P4(3P) 3D 4D 4

F	1	9	128064.10	420
NE	2	10	279139.96	PM68
NA	3	11	460267.8	487
MG	4	12	676827.8	710
AL	5	13	919900.	487
SI	6	14	(1192000.)	374
P	7	15	(1496000.)	374
S	8	16	1831370.	487
CL	9	17	(2196000.)	374
AR	10	18	(2591000.)	374
K	11	19	(3020000.)	374
CA	12	20	(3500000.)	374

1S2 2S2 2P4(3P) 3D 2D 2

F	1	9	128219.83	420
NE	2	10	280475.90	PM68
NA	3	11	465027.9	487
MG	4	12	680030.	487
AL	5	13	925430.	487
SI	6	14	1201100.	487
P	7	15	1506730.	487
S	8	16	1842770.	487
CL	9	17	(2210000.)	374
AR	10	18	(2615000.)	374
K	11	19	(3040000.)	374
CA	12	20	(3500000.)	374
SC	13	21	3987000.	143
TI	14	22	*4558200.*	143
V	15	23	*5066000.*	143
CR	16	24	5653000.	143
MN	17	25	*6231000.*	143
FE	18	26	*6916000.*	208
CO	19	27	7587000.	143

TABLE XV FLUORINE ISOELECTRONIC SEQUENCE (cont.)

1S2 2S2 2P4(3P) 3D 2D 3

F	1	9	128140.48	420
NE	2	10	280271.29	PM68
NA	3	11	464392.1	487
MG	4	12	678403.	487
AL	5	13	926400.	487
SI	6	14	1202960.	487
P	7	15	1502040.	487
S	8	16	1847810.	487
CL	9	17	(2210000.)	374
AR	10	18	2616430.	259
K	11	19	(3040000.)	374
CA	12	20	(3500000.)	374
SC	13	21	4005000.	143
TI	14	22	4531000.	143
V	15	23	5087000.	143
CR	16	24	5675000.	143
MN	17	25	6297000.	143
FE	18	26	6959000.	143
CO	19	27	7639000.	143
NI	20	28	8354000.	143
CU	21	29	9099000.	143

1S2 2S2 2P4(1D) 3D 2D 2

F	1	9	(160000.)	374
NE	2	10	306265.06	PM68
NA	3	11	493853.2	487
MG	4	12	712120.	487
AL	5	13	963330.	487
SI	6	14	1243860.	487
P	7	15	1554420.	487
S	8	16	1898220.	487
CL	9	17	(2275000.)	374
AR	10	18	2672370.	259
K	11	19	(3105000.)	374
CA	12	20	(3560000.)	374

1S2 2S2 2P4(1D) 3D 2D 3

F	1	9	(160000.)	374
NE	2	10	306245.71	PM68
NA	3	11	494599.0	487
MG	4	12	713389.	487
AL	5	13	962640.	487
SI	6	14	1242220.	487
P	7	15	1553740.	487
S	8	16	1892000.	487
CL	9	17	(2275000.)	374
AR	10	18	2672370.	259
K	11	19	(3105000.)	374
CA	12	20	(3560000.)	374
SC	13	21	4047000.	143
TI	14	22	4568000.	143
V	15	23	5120000.	143
CR	16	24	5701000.	143
MN	17	25	6317000.	143
FE	18	26	6935000.	208
CO	19	27	7616000.	143
NI	20	28	8292000.	143
CU	21	29	9025000.	143

TABLE XV FLUORINE ISOELECTRONIC SEQUENCE (cont.)

1S2 2S2 2P4(1S) 3D 2D 2

F	1	9	(171000.)	374
NE	2	10	(335000.)	374
NA	3	11	529498.	487
MG	4	12	752965.	487
AL	5	13	1007290.	487
SI	6	14	1291800.	487
P	7	15	1606880.	487
S	8	16	1953010.	487
CL	9	17	2330130.	487
AR	10	18	(2739000.)	374
K	11	19	(3179000.)	374
CA	12	20	3652400.	487
SC	13	21	4157000.	143
TI	14	22	4688000.	143
V	15	23	5264000.	143
CR	16	24	5860000.	143
MN	17	25	*6507000.*	143
FE	18	26	*7173000.*	143
CO	19	27	*7889000.*	143
NI	20	28	*8607000.*	143
CU	21	29	*9364000.*	143
ZN	22	30	(10140000.)	374

1S2 2S2 2P4(1S) 3D 2D 3

F	1	9	(171000.)	374
NE	2	10	(335000.)	374
NA	3	11	529465.	487
MG	4	12	752927.	487
AL	5	13	1007150.	487
SI	6	14	1291510.	487
P	7	15	1606550.	487
S	8	16	1952100.	487
CL	9	17	2328830.	487
AR	10	18	(2737000.)	374
K	11	19	(3177000.)	374
CA	12	20	3648000.	487
SC	13	21	4151000.	143
TI	14	22	4684000.	143
V	15	23	5252000.	143
CR	16	24	5851000.	143
MN	17	25	6494000.	143
FE	18	26	7128000.	143
CO	19	27	7834000.	143
NI	20	28	8554000.	143
CU	21	29	9311000.	143
ZN	22	30	(10090000.)	374

TABLE XVI

TRANSITIONS - FLUORINE ISOELECTRONIC SEQUENCE

		F I	Ne II	Na III	Mg IV	Al V	Si VI	P VII	S VIII
$2p^5 - 2s2p^6$	$^2P^0_{3/2} - {}^2S_{1/2}$	588.84	460.72	378.14	321.00	278.70	246.00	219.91	198.55
$2p^5 - 2p^4(^1S)3s$	$^2P^0_{3/2} - {}^2S_{1/2}$	671.21	361.43	229.87	160.23	118.50	91.37	72.68	59.24
$2p^5 - 2p^4(^1S)3d$	$^2P^0_{3/2} - {}^2D_{5/2}$	(584.79)	(298.51)	188.87	132.82	99.29	77.43	62.24	51.23
$2p^5 - 2p^4(^3P)3s$	$^2P^0_{3/2} - {}^2P_{3/2}$	954.83	446.25	267.64	180.62	130.85	99.46	78.29	63.30
$2p^5 - 2p^4(^3P)3d$	$^2P^0_{3/2} - {}^2P_{3/2}$	776.93	354.96	214.24	146.53	107.71	83.00	66.17	54.13
	$^2P^0_{3/2} - {}^2D_{5/2}$	780.39	356.80	215.33	147.40	107.94	83.12	66.57	54.12
$2p^5 - 2p^4(^1D)3d$	$^2P^0_{3/2} - {}^2S_{1/2}$	(671.14)	326.78	200.90	139.99	104.07	80.57	64.29	52.79
	$^2P^0_{3/2} - {}^2P_{3/2}$	(666.67)	327.26	202.72	140.48	103.99	80.49	64.43	52.70
	$^2P^0_{3/2} - {}^2D_{5/2}$	(625.00)	326.53	202.18	140.18	103.88	80.50	64.36	52.85
$2p^4(^3P)3s - 2p^4(^3P)3p$	$^4P_{5/2} - {}^4S^0_{3/2}$	6241.38	2956.59	1951.21	1459.57	(1172.47)	(984.83)	(852.73)	
$2p^4(^3P)3p - 2p^4(^3P)3d$	$^4S^0_{3/2} - {}^4P_{5/2}$	9824.85	3543.86	2181.41	1548.07	(1169.04)	(950.30)	(834.10)	
	$^4S^0_{3/2} - {}^4D_{5/2}$	10351.95	3807.33	2325.28	1548.29	(1207.73)	(1000.00)	(840.34)	

Note: Transitions in Angstroms. ( ) indicates prediction.

TABLE XVI

TRANSITIONS - FLUORINE ISOELECTRONIC SEQUENCE (continued)

		Cl IX	Ar X	K XI	Ca XII	Sc XIII	Ti XIV	V XV
$2p^5 - 2s2p^6$	$^2P^0_{3/2} - {}^2S_{1/2}$	180.70	165.57	152.45	141.05	130.96	122.01	(113.99)
$2p^5 - 2p^4(^1S)3s$	$^2P^0_{3/2} - {}^2S_{1/2}$	49.23	41.56	(35.78)	(31.06)	(27.23)		
$2p^5 - 2p^4(^1S)3d$	$^2P^0_{3/2} - {}^2D_{5/2}$	42.94	(36.54)	(31.48)	27.41	24.09	21.35	19.04
$2p^5 - 2p^4(^3P)3s$	$^2P^0_{3/2} - {}^2P_{3/2}$	52.30	43.93	37.44	32.28	28.13	24.73	21.92
$2p^5 - 2p^4(^3P)3d$	$^2P^0_{3/2} - {}^2P_{3/2}$	(45.21)	(38.32)	(32.93)	(28.61)	25.12	22.21	19.78
	$^2P^0_{3/2} - {}^2D_{5/2}$	(45.25)	38.22	(32.89)	(28.57)	24.97	22.07	19.66
$2p^5 - 2p^4(^1D)3d$	$^2P^0_{3/2} - {}^2S_{1/2}$	(44.15)	37.59	(32.27)	(28.07)	24.65	22.07	19.47
	$^2P^0_{3/2} - {}^2P_{3/2}$	(44.11)	37.44	(32.19)	(27.99)	24.56	21,73	19.38
	$^2P^0_{3/2} - {}^2D_{5/2}$	(43.95)	37.42	(32.21)	(28.09)	24.71	21.89	19.53
$2p^4(^3P)3s - 2p^4(^3P)3p$	$^4P_{5/2} - {}^4S^0_{3/2}$							
$2p^4(^3P)3p - 2p^4(^3P)3d$	$^4S^0_{3/2} - {}^4P_{5/2}$							
	$^4S^0_{3/2} - {}^4D_{5/2}$							

TABLE XVI

TRANSITIONS - FLUORINE ISOELECTRONIC SEQUENCE (continued)

		Cr XVI	Mn XVII	FE XVIII	Co XIX	Ni XX	Cu XXI	Zn XXII
$2p^5 - 2s2p^6$	$^2P^0_{3/2} - {}^2S_{1/2}$	(106.76)	(100.20)	(94.25)	(88.81)	(83.68)	(79.05)	(74.79)
$2p^5 - 2p^4(^1S)3s$	$^2P^0_{3/2} - {}^2S_{1/2}$							
$2p^5 - 2p^4(^1S)3d$	$^2P^0_{3/2} - {}^2D_{5/2}$	17.09	15.40	14.03	12.76	11.69	10.74	(9.91)
$2p^5 - 2p^4(^3P)3s$	$^2P^0_{3/2} - {}^2P_{3/2}$	19.55	17.59	15.88	14.42	13.14	(12.04)	(11.07)
$2p^5 - 2p^4(^3P)3d$	$^2P^0_{3/2} - {}^2P_{3/2}$	17.74	15.98	14.48	13.23	12.09	11.10	
	$^2P^0_{3/2} - {}^2D_{5/2}$	17.62	15.88	14.37	13.09	11.97	10.99	
$2p^5 -2p^4(^1D)3d$	$^2P^0_{3/2} - {}^2S_{1/2}$	17.41	15.77	14.34				
	$^2P^0_{3/2} - {}^2P_{3/2}$	17.38	15.67	14.20	12.94	11.84	(10.87)	(10.02)
	$^2P^0_{3/2} - {}^2D_{5/2}$	17.54	15.83	14.42	13.13	12.06	11.08	
$2p^4(^3P)3s - 2p^4(^3P)3p$	$^4P_{5/2} - {}^4S^0_{3/2}$							
$2p^4(^3P)3p - 2p^4(^3P)3d$	$^4S^0_{3/2} - {}^4P_{5/2}$							
	$^4S^0_{3/2} - {}^4D_{5/2}$							

TABLE XVII NEON ISOELECTRONIC SEQUENCE

1S2 2S 2P6( ) 3P 3P* 1				
AL	4	13	(1074000.)	374
SI	5	14	(1351000.)	374
P	6	15	(1660000.)	374
S	7	16	2000400.	487
CL	8	17	*2371580.*	487
AR	9	18	(2782000.)	374
K	10	19	3219400.	487
CA	11	20	3692900.	487
SC	12	21	4198000.	232
TI	13	22	4733000.	265
TI	13	22	4733300.	232
V	14	23	5299400.	232
CR	15	24	5894500.	487
MN	16	25	6530800.	487
FE	17	26	7201000.	487
CO	18	27	7898300.	487
NI	19	28	8628000.	264
CU	20	29	9390000.	264
ZN	21	30	(10190000.)	374

1S2 2S 2P6( ) 3P 1P* 1				
AL	4	13	(1075000.)	374
SI	5	14	(1352000.)	374
P	6	15	(1662000.)	374
S	7	16	2000400.	487
CL	8	17	*2401770.*	487
AR	9	18	2791740.	259
K	10	19	3237600.	487
CA	11	20	3708900.	487
SC	12	21	4215400.	232
TI	13	22	4752000.	232
TI	13	22	4753000.	265
V	14	23	5324200.	232
CR	15	24	5921000.	487
MN	16	25	6562500.	487
FE	17	26	7235900.	487
CO	18	27	7937100.	487
NI	19	28	8673000.	264
CU	20	29	9434000.	264
ZN	21	30	10235000.	264

TABLE XVIII

TRANSITIONS - NEON ISOELECTRONIC SEQUENCE

		Ne I	Na II	Mg III	Al IV	Si V	P VI	S VII	Cl VIII	Ar IX	K X
$2s^2 2p^6 - 2s2p^6 3p$	$^1S_o - {}^1P_1^o$				(93.02)	(73.96)	(60.17)	49.99	41.63	35.82	30.89
	$^1S_o - {}^3P_1^o$				(93.11)	(74.02)	(60.24)	49.99	42.17	(35.94)	31.06

		Ca XI	Sc XII	Ti XIII	V XIV	Cr XV	Mn XVI	Fe XVII	Co XVIII	Ni XIX	Cu XX	Zn XXI
$2s^2 2p^6 - 2s2p^6 3p$	$^1S_o - {}^1P_1^o$	26.96	23.72	21.04	18.78	16.89	15.24	13.82	12.60	11.53	10.60	9.77
	$^1S_o - {}^3P_1^o$	27.07	23.82	21.13	18.87	16.96	15.31	13.89	12.66	11.59	10.65	(9.81)

Note: Transitions in Angstroms.

( ) indicates prediction.

$^1S_o - {}^3P_1^o$ is an intercombination transition.

TABLE XIX SODIUM ISOELECTRONIC SEQUENCE

( ) 5S 2S 1

NA	1	11	33200.696	487
MG	2	12	92790.51	592
AL	3	13	170637.35	826
SI	4	14	265417.95	504
P	5	15	376639.2	487
S	6	16	504112.	487
CL	7	17	647677.	487
AR	8	18	812422.	487
K	9	19	979901.	487
CA	10	20	1170098.	487
SC	11	21	1382110.	487
TI	12	22	(1602000.)	374
V	13	23	(1841000.)	374
CR	14	24	(2097000.)	374
MN	15	25	(2371000.)	374
FE	16	26	2662230.	266
CO	17	27	(2973000.)	374
NI	18	28	(3304000.)	374

( ) 5P 2P* 1

NA	1	11	35040.27	487
MG	2	12	97455.12	592
AL	3	13	178433.43	826
SI	4	14	276503.67	504
P	5	15	391101.7	487
S	6	16	522030.	487
CL	7	17	(668400.)	374
AR	8	18	832245.	487
K	9	19	(1011000.)	374
CA	10	20	(1207000.)	374
SC	11	21	1418280.	487
TI	12	22	1645820.	487
V	13	23	1889360.	487
CR	14	24	2149290.	178
MN	15	25	(2425000.)	374
FE	16	26	(2718000.)	374
CO	17	27	(3026000.)	374
NI	18	28	(3350000.)	374

( ) 5P 2P* 2

NA	1	11	35042.79	487
MG	2	12	97468.92	592
AL	3	13	178470.32	826
SI	4	14	276579.03	504
P	5	15	391242.4	487
S	6	16	522248.	487
CL	7	17	(668800.)	374
AR	8	18	832691.	487
K	9	19	(1012000.)	374
CA	10	20	(1208000.)	374
SC	11	21	1419550.	487
TI	12	22	1647310.	437
V	13	23	1891430.	487
CR	14	24	2152020.	178
MN	15	25	(2429000.)	374
FE	16	26	2723310.	266
CO	17	27	(3031000.)	374
NI	18	28	3355700.	266

			( ) 6S 2S 1	
NA	1	11	36372.647	487
MG	2	12	103196.75	592
AL	3	13	191484.23	826
SI	4	14	299676.95	504
P	5	15	427157.	487
S	6	16	573823.	487
CL	7	17	(739700.)	374
AR	8	18	(924200.)	374
K	9	19	(1127000.)	374
CA	10	20	(1349000.)	374
SC	11	21	1588790.	487
TI	12	22	(1848000.)	374
V	13	23	(2125000.)	374
CR	14	24	(2422000.)	374
MN	15	25	(2739000.)	374
FE	16	26	3075170.	266
CO	17	27	(3432000.)	374
NI	18	28	(3811000.)	374

			( ) 6P 2P* 1	
NA	1	11	37296.51	487
MG	2	12	105622.34	592
AL	3	13	195621.72	826
SI	4	14	305641.10	504
P	5	15	435100.4	487
S	6	16	583679.	487
CL	7	17	(751700.)	374
AR	8	18	(938200.)	374
K	9	19	(1143000.)	374
CA	10	20	(1367000.)	374
SC	11	21	1609480.	017
TI	12	22	(1871000.)	374
V	13	23	(2151000.)	374
CR	14	24	(2450000.)	374
MN	15	25	(2770000.)	374
FE	16	26	3109450.	266
CO	17	27	(3470000.)	374
NI	18	28	(3853000.)	374

			( ) 6P 2P* 2	
NA	1	11	37297.76	487
MG	2	12	105629.72	592
AL	3	13	195641.74	826
SI	4	14	305682.27	504
P	5	15	435100.4	487
S	6	16	583679.	487
CL	7	17	(751700.)	374
AR	8	18	(938200.)	374
K	9	19	(1143000.)	374
CA	10	20	(1367000.)	374
SC	11	21	1609480.	017
TI	12	22	(1871000.)	374
V	13	23	(2151000.)	374
CR	14	24	(2450000.)	374
MN	15	25	(2770000.)	374
FE	16	26	3109450.	266
CO	17	27	(3470000.)	374
NI	18	28	(3853000.)	374

TABLE XIX SODIUM ISOELECTRONIC SEQUENCE (cont.)

2P5 3S2( )				2P* 1
K	9	19	(2351000.)	374
CA	10	20	(2748000.)	374
SC	11	21	(3176000.)	374
TI	12	22	3637900.	265
V	13	23	4131900.	265
CR	14	24	4658300.	265
MN	15	25	*5220600.*	265
FE	16	26	5811900.	265
CO	17	27	6430500.	265
NI	18	28	7092000.	265
CU	19	29	(7780000.)	374
ZN	20	30	(8502000.)	374

2P5 3S2( )				2P* 2
K	9	19	(2328000.)	374
CA	10	20	(2720000.)	374
SC	11	21	(3142000.)	374
TI	12	22	3594700.	265
V	13	23	4078800.	265
CR	14	24	4593500.	265
MN	15	25	*5141400.*	265
FE	16	26	5717200.	265
CO	17	27	6317900.	265
NI	18	28	6959000.	265
CU	19	29	7628000.	265
ZN	20	30	(8326000.)	374

TABLE XX

TRANSITIONS - SODIUM ISOELECTRONIC SEQUENCE

		Na I	Mg II	Al III	Si IV	P V	S VI	Cl VII	Ar VIII	K IX	Ca X
3p - 5s	$^2P^0_{1/2} - {}^2S_{1/2}$	6155.92	1750.66	855.04	515.12	347.24	251.11	190.59	148.73	121.54	100.41
	$^2P^0_{3/2} - {}^2S_{1/2}$	6162.44	1753.47	856.75	516.34	348.20	251.90	191.28	149.33	122.10	100.93
3p - 6s	$^2P^0_{1/2} - {}^2S_{1/2}$	5150.27	1480.88	725.68	437.85	295.42	213.70	(162.15)	(127.53)	(103.11)	(85.12)
	$^2P^0_{3/2} - {}^2S_{1/2}$	5154.83	1482.89	726.92	438.73	296.11	214.28	(162.65)	(127.97)	(103.51)	(85.49)
3s - 5p	$^2S_{1/2} - {}^2P^0_{1/2}$	2853.86	1026.11	560.43	361.66	255.69	191.56	(149.61)	120.16	(98.91)	(82.85)
	$^2S_{1/2} - {}^2P^0_{3/2}$	2853.65	1025.97	560.32	361.56	255.60	191.48	(149.52)	120.09	(98.81)	(82.78)
3s - 6p	$^2S_{1/2} - {}^2P^0_{1/2}$	2681.22	946.77	511.19	327.18	229.83	171.33	(133.03)	(106.59)	(87.49)	(73.15)
	$^2S_{1/2} - {}^2P^0_{3/2}$	2681.12	946.70	511.14	327.14	229.83	171.33	(133.03)	(106.59)	(87.49)	(73.15)
$2p^63s - 2p^53s^2$	$^2S_{1/2} - {}^2P^0_{1/2}$									(42.54)	(36.39)
	$^2S_{1/2} - {}^2P^0_{3/2}$									(42.96)	(36.76)

Note: Transitions in Angstroms

( ) indicates prediction.

TABLE XX

TRANSITIONS - SODIUM ISOELECTRONIC SEQUENCE (continued)

		Sc XI	Ti XII	V XIII	Cr XIV	Mn XV	Fe XVI	Co XVII	Ni XVIII	Cu XIX	Zn XX
3p - 5s	$^2P^0_{1/2} - {}^2S_{1/2}$	83.96	(71.76)	(61.90)	(53.93)	(47.37)	41.92	(37.32)	(33.40)		
	$^2P^0_{3/2} - {}^2S_{1/2}$	84.43	(72.21)	(62.32)	(54.33)	(47.76)	42.30	(37.68)	(33.75)		
3p - 6s	$^2P^0_{1/2} - {}^2S_{1/2}$	71.54	(60.99)	(52.64)	(45.89)	(40.34)	35.74	(31.86)	(28.56)		
	$^2P^0_{3/2} - {}^2S_{1/2}$	71.89	(61.31)	(52.95)	(46.18)	(40.62)	36.01	(32.12)	(28.82)		
3s - 5p	$^2S_{1/2} - {}^2P^0_{1/2}$	70.51	60.76	52.93	46.53	(41.24)	(36.79)	(33.05)	(29.85)		
	$^2S_{1/2} - {}^2P^0_{3/2}$	70.44	60.70	52.87	46.46	(41.17)	36.72	(32.99)	29.80		
3s - 6p	$^2S_{1/2} - {}^2P^0_{1/2}$	62.13	(53.45)	(46.49)	(40.82)	(36.10)	32.16	(28.82)	(25.95)		
	$^2S_{1/2} - {}^2P^0_{3/2}$	62.13	(53.45)	(46.49)	(40.82)	(36.10)	32.16	(28.82)	(25.95)		
$2p^6 3s - 2p^5 3s^2$	$^2S_{1/2} - {}^2P^0_{1/2}$	(31.49)	27.49	24.20	21.47	19.15	17.21	15.55	14.10	(12.85)	(11.76)
	$^2S_{1/2} - {}^2P^0_{3/2}$	(31.83)	27.82	24.52	21.77	19.45	17.49	15.82	14.37	13.11	(12.01)

TABLE XXI

COMPARISON OF TRANSITIONS IN THE SI VI SPECTRUM

2s2p - 2p3p	$^1P^0_1 - {}^1P_1$	(46.66)	[46.62]	46.67
$2p^2$ - 2p3s	$^1S_0 - {}^1P^0_1$	(53.70)	[53.73]	
2s2p - 2s3s	$^3P^0_0 - {}^3S_1$	(49.01)	[49.01]	49.05
	$^3P^0_1 - {}^3S_1$	(49.08)	[49.07]	
	$^3P^0_2 - {}^3S_1$	(49.21)	[49.20]	*49.24
2s2p - 2p3p	$^3P^0_0 - {}^3S_1$	(42.90)	[42.92]	
	$^3P^0_2 - {}^3S_1$	(42.95)	[42.97]	
	$^3P^0_2 - {}^3S_1$	(43.04)	[43.06]	

Note: Transitions in Angstroms.

( ) indicates prediction by [374].

[ ] indicates prediction by [776].

other values observed.

* blend

TABLE XXII

COMPARISON OF ENERGY LEVELS IN THE OXYGEN ISOELECTRONIC SEQUENCE

$2p^4$ Configuration

	$^3P_0$	
Sc XIV	(36200)	34450
Ti XV	(44800)	38335
V XVI	(54900)	48617
Cr XVII	(66700)	56359
	$^3P_1$	
Sc XIV	(31200)	30425
Ti XV	(39300)	38335
V XVI	(48900)	47700
Cr XVII	(60200)	58765
	$^1S_0$	
Ar XI	(143000)	149188
K XII	(154000)	163500
Ca XIII	(165000)	179180
Sc XIV	(175000)	196440
	$^1D_2$	
Cl X	(62600)	65262
Ar XI	(67900)	72338
K XII	(73200)	80080
Ca XIII	(78400)	88742

$2p^3 3s$ Configuration

	$^1D^0_2$	
K XII	(3013000)	3024740
Ca XIII	(3459000)	3474352
Sc XIV	(3936000)	3954690

$2p^3 3s$ Configuration

	$^3S^0_1$	
K XII	(2929000)	2929158
Ca XIII	(3373000)	3372241
Sc XIV	(3847000)	3845688
Ti XV	(4351000)	4349327
	$^3P^0_0$	
Mg V	(756450)	756810
Al VI	(993600)	994320
Si VII	(1261400)	1262528
S IX	(1888000)	1891250
	$^3P^0_1$	
S IX	(1889000)	1891851
Cl X	(2248500)	2252706
Ar XI	(2638000)	2644489
	$^3P^0_2$	
S IX	(1891000)	1893325
Cl X	(2251000)	2255119
Ar XI	(2642000)	2648298
	$^1P^0_1$	
Ar XI	(2653000)	2663504
K XII	(3074000)	3088799
Ca XIII	(3525000)	3545616
Sc XIV	(4008000)	4034152
	$^3D^0_3$	
Ar XI	(2589000)	2590000
K XII	(3007000)	3008090
Ca XIII	(3455000)	3456980

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13. ABSTRACT

Approximately 900 unknown atomic energy levels were predicted by extrapolation along the helium through sodium isoelectronic sequences. The extrapolations, based on well known regularities in atomic spectra, extend beyond the range of known values providing predictions in highly ionized atoms. The predicted energy levels are presented, along with the known values, in tabular form. In addition, as an aid to spectroscopists, 116 transitions are listed with known and predicted wavelengths. Since the majority of the energy level predictions are in highly ionized atoms, most of the predicted wavelengths fall in the vacuum ultraviolet region of the spectrum.

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