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OPTICAL CONSTANTS OF CARBON-HYDROGEN MIXTURES

by

Roger P. Main

HELIODYNE CORPORATION
a division of KMS Industries, Inc.

prepared for

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

NASA Lewis Research Center
Contract NAS 3-11842

Richard W. Patch, Project Manager

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FINAL REPORT

OPTICAL CONSTANTS OF CARBON-HYDROGEN MIXTURES

by

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Van Nuys, California 91405

prepared for

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

May 20, 1969

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NASA Lewis Research Center
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ABSTRACT

The equilibrium compositions and linear spectral absorption coefficients and Planck and Rosseland mean absorption coefficients have been computed for carbon-hydrogen mixtures with carbon/hydrogen mass ratios of 0.005, 0.01 and 0.05, temperatures of 1600, 2200, 3000, 4000, 5000, 6500, 8000, and 10,000°K, and gas pressures of 100, 500, and 1000 atmospheres for the wave number range 7000 - 68,000 cm^{-1} (approximately). The possible presence of condensed carbon has been considered in the composition calculations, but none was found. The major absorption was found to be due to molecular electronic transitions in H_2, CH_3, C_2H, and C_2H_4, and to H^- photodetachment and neutral free-free processes, although each did not contribute strongly for all of the temperatures, pressures, C/H mass ratios, and spectral frequencies considered, of course.

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SUMMARY

The purpose of this work is to calculate the optical constants (spectral absorption coefficients and Planck and Rosseland mean absorption coefficients) of carbon-hydrogen mixtures for application to the design of gaseous-core nuclear rocket propulsion systems. We have calculated the equilibrium compositions, and from these the optical constants, for such mixtures for total gas pressures of 100, 500, and 1000 atmospheres, gas temperatures of 1600, 2200, 3000, 4000, 5000, 6500, 8000, and 10,000 °K, with carbon/hydrogen mass ratios of 0.005, 0.01, and 0.05, a total of 72 cases. The computer calculations of equilibrium composition include 65 species, among them solid carbon (graphite). The computer calculations of the optical constants included absorption by molecular electronic transitions, comprised of 16 transitions in the diatomic molecules H_2, CH, CH^+ and C_2, and 23 transitions in the triatomic and polyatomic molecules CH_2, CH_3, C_2H, C_2H_2, C_2H_4, C_3, and C_6H_6 (benzene), photoionization absorption by C- and H- atoms, radiative association absorption by H-atoms, photodetachment absorption by C^- and H^- ions, and free-free absorption by electrons in the fields of neutral and singly-ionized species. The pressure-induced absorption by H_2 molecues was ignored in these calculations.

The composition calculations showed that no condensed carbon (graphite), either solid or liquid, was present in any of the mixtures. The principal species in the mixtures were H_2 and CH_4 at the lower temperatures considered, and H_2, H, C, C_2, CH, C_2H, and C_2H_2, at the higher temperatures. The optical absorption is principally due to electronic transitions in molecules and to H^- photodetachment and the neutral free-free processes, the contribution of each varying with the gas conditions, of course. The omission of the pressure-induced spectrum of the H_2 molecule appears to give significant errors in the computed optical constants at the lower temperatures considered, and this is probably the major limitation of the results reported here. The optical constants exceed 1. cm^{-1} by a goodly amount at the higher temperatures and pressures considered, a major fact to be considered in the design of nuclear propellant systems using carbon-seeded hydrogen gas as a propellant.

INTRODUCTION

The optical constants (spectral absorption coefficients, spectral emissivities, and spectrally-averaged opacities of various types) of complex equilibrium gas mixtures are of great interest in many fields, including astrophysics, missile re-entry physics, and nuclear rocket technology. Many years have been devoted to the study of the optical constants of air to high temperatures for a wide range of pressures. The first calculations of the optical constants of carbon vapor and carbon-air mixtures to high temperatures were performed by Main and Bauer[1] in 1964, and this work was extended by them [2, 3] to the thermal decomposition products of composite missile heat shield materials and hydrocarbon-air mixtures at high temperatures and high pressures. Main [4] has further extended this work to fluorocarbon-air mixtures and Hooker, Morsell, and Main [5] have published a combined experimental and theoretical study of the optical constants of thermally decomposed phenolic carbon and phenolic silica, both mixed with air and mixed with inert argon diluent. Experimental studies of the optical constants of thermally decomposed Teflon and Teflon-nitrogen mixtures to high temperatures have also been reported in the literature[6]. Later authors have published in the open literature theoretical studies of the optical constants of various missile heat shield materials for application to missile re-entry problems [7, 8] relating closely to the earlier theoretical work of Main and Bauer [1, 2, 3, 4] and to the present work.

The state-of-the-art of the theoretical calculations has now advanced to the stage where meaningful calculations of the optical constants of complex gas mixtures can now be routinely undertaken with the aid of large computers; the principal uncertainties, in these calculations usually arise from our lack of adequate experimental studies of such requisite quantities as oscillator strengths of molecular transitions, thermochemical parameters, etc.

To calculate the optical constants of a complex equilibrium gas mixture, one must first calculate its equilibrium species composition. This requires computer calculations, usually based on free-energy minimization, for the temperatures, pressures, and initial compositions of interest. With the equilibrium species compositions in hand, the optical constants can then be calculated utilizing detailed information on the intensities and spectral distributions of the important radiative and absorptive processes. For complex gas mixtures,

usually many such processes must be taken into account. For example, in the computer calculations of Main and Bauer for hydrocarbon-air mixtures [2], it was necessary for the temperatures and pressures considered to take into account 52 electronic band systems in diatomic molecules, 42 electronic band systems in triatomic and polyatomic molecules, photodetachment from C^-, O^-, and H^- negative ions, free-free processes involving positive ions and neutral species, and radiative association of hydrogen atoms. It is necessary in such calculations to make many approximations, partly to keep their complexity within reasonable bounds, and partly to take account of the inadequate experimental and theoretical data that must be used in them. Nevertheless, the theoretical calculations appear to agree reasonably well with experiment in even thermochemically complicated cases [5]. For this reason, it is realistic to expect reasonably accurate theoretical results for the optical constants of the carbon-hydrogen mixtures considered in the present work, subject to the qualifications and uncertainties to be named and discussed later.

In the present work we calculate the equilibrium compositions and optical constants (linear spectral absorption coefficients and Planck and Rosseland mean opacities) for carbon-hydrogen mixtures specified by all combinations of the following conditions:

Carbon/Hydrogen Mass Ratio = 0.005, 0.01, and 0.05

Temperatures = 1600, 2200, 3000, 4000, 5000, 6500, 8000, and 10,000°K

Total Gas Pressures = 100, 500, and 1000 atmospheres,

a total of 72 cases in all. The equilibrium compositions are calculated using a standard computer program, for an assumed set of final species, including solid carbon (graphite). The optical constants are calculated using a computer program developed by the present author, and which takes account of the important radiative absorption mechanisms for all species for which adequate quantitative spectroscopic data exist. This is the first theoretical study of this nature for carbon-hydrogen mixtures, and its results are intended to be of use in the design of gaseous-core nuclear rockets. It will be important in this connection to define as accurately as possible the uncertainties existing in the calculations reported herein, since engineering decisions should take such uncertainties into account.

The main results of this work are given in the present report, and a copy of the print-out of the computer calculations of equilibrium compositions is given herein. However, only the major results for the optical constants are reproduced here. A complete copy of the print-out of the optical constants, which includes columns giving the contributions due to each molecular band system and each absorption mechanism for each mixture, has not been given in the present report due to its great length (c. 800 pages), but discussion of this sufficient for most purposes is given in the text here.

CALCULATIONS OF COMPOSITIONS

The HUG Composition Program

The equilibrium compositions of the carbon-hydrogen mixtures of interest were calculated with the HUG computer program[9]. This program can optionally solve the Rankine-Hugoniot equations for normal shock waves in reactive gas mixtures, or compute the equilibrium composition of reactive gas mixtures for specified end conditions of temperature and pressure (only the latter option is of interest here). The technique used for finding equilibrium compositions is that of minimization of the thermodynamic free-energy, subject to conservation conditions, by the Brinkley method[10], as extended to two-phase systems by Fickett[11]. The HUG program incorporates a simultaneous consideration of a two-phase equilibrium with the single-phase equilibrium of the gaseous species; thus, in the present work, the carbon gas-solid equilibrium may be separately considered, and the fractional amount of condensed carbon, where it occurs, will be computed by the HUG program. The HUG program is currently run on an IBM 360-65 machine emulating the IBM 7094.

The input data to the HUG program are the dimensionless

enthalpies and free energies and the heats of formation (at $0^{\circ}K$) of the species to be included in the equilibrium composition calculations, the initial species composition of the mixtures, and the final temperatures and pressures desired. The HUG program has been in regular use at Heliodyne Corporation for over four years, and we have compared the results obtained with it to those obtained by other workers using similar computer programs. We find excellent agreement in all cases where comparisons are possible, and we unhesitatingly made use of the HUG program in the present work.

A feature of the HUG computer program worth noting is that in the input data certain species must be specified as "independent species"; the number of such species must be equal to the number of fundamental components of the mixtures to be considered, and the independent species must collectively contain all of these fundamental components. For the present calculations, the fundamental components are C, H, C(s; graphite), and e^- (free electrons), and all of the species in the mixtures considered are formed from these. We have chosen as basic independent species the two sets:

CH_4; H_2; C(s; graphite); e^- (low temperatures)

C; H; C(s; graphite); e^- (high temperatures).

A limitation of the HUG program as presently established is that when the computed mole fraction of an independent species drops in value below 10^{-6}, then all computations will cease. This is not generally a serious limitation, since nearly always substitution of an alternative set of independent species will yield results. However, when the computed mole fraction of free electrons, e^-, is less than 10^{-6}, then neither the mole fraction of e^- nor that of any ionized species can be computed. Also, the "machine zero" for the IBM System 360 emulating the IBM 7094 is $1.8048514 \times 10^{-35}$, and this is the smallest mole fraction which can be computed. Mole fractions that are less than or equal to this number are printed-out as this number. This causes an error for species whose mole fractions are less than this number, but such an error is never serious in the present work.

For the composition calculations, we have transformed the C/H mass ratios to be considered to initial mole fractions which sum to unity to five decimal places, as required by the HUG com-

puter program. Using the standard atomic weights (chemical scale) for C(12.010 gm/mole) and H(1.0080 gm/mole), we find:

C/H Mass ratio	Initial mole fractions C	H
0.005	0.00041947	0.99958053
0.01	0.00083860	0.99916140
0.05	0.0041790	0.9958210

These values for the initial mole fractions have been used in the composition calculations of the present work.

We have written at Heliodyne Corporation a computer program to compute fourth-degree polynomial temperature fits to the thermodynamic functions of species for use with the HUG program. This computer program generates "least squares" best temperature fits to tabular data for the dimensionless enthalpy, $(H_T^o - H_0^o)/RT$, and the dimensionless free energy, $(F_T^o - H_0^o)/RT$, according to:

$$\frac{H_T^o - H_0^o}{RT} = A + BT + CT^2 + DT^3 + ET^4 \tag{1}$$

$$\frac{F_T^o - H_0^o}{RT} = A\,(1 - \ln T) - BT - \frac{1}{2}CT^2 - \frac{1}{3}DT^3 - \frac{1}{4}ET^4 - K, \tag{2}$$

which are the formats required by the HUG program[9]. Duff and Bauer[12] have found that, on average, these optimized fits can reproduce the input tabular data to within a small fraction of one per cent, and we have generally verified this. Values for the entropies and specific heats may be obtained from these fit coefficients.

The least squares evaluation of the fit coefficients in Eqs. (1) and (2) can be limited to any temperature range. For many species considered here, these fit coefficients were already available in the literature for much of the temperature range of interest,

and these have been adopted here (cf. Table 1). Most of the thermodynamic data for the species of interest here, whether tabular or in the form of the fit coefficients, extends (or are valid) only to $T = 6000^\circ K$ (cf. Table 1). In order to perform the composition calculations, we have used the fit coefficients, whether calculated by us or by others, up to the highest temperature considered here, $T = 10,000^\circ K$, even though their validity in this connection is questionable. This will introduce unknown errors into our composition calculations for $T > 6000^\circ K$, but no alternative to this approach is feasible in work of the present type.

Species Considered

The choice of species to be considered in the composition calculations has been based on the author's conjectures of those expected to be present in the mixtures considered for the conditions of interest, on the basis of previous work related to the work at hand (principally that of Ref. 12), and on the availability of the required thermodynamic functions.

Based on these considerations, the species listed in Table 1 have been included in the composition calculations. For the more complex species, we have used thermodynamic data appropriate to the "average" over all known isomers with a given chemical formula. This procedure was used by Duff and Bauer[12] in their calculations of the compositions of carbon-hydrogen mixtures, and we have usually, where such an "averaging" was necessary, used their recommended and properly weighted "average" fit coefficients (Eqs. (1) and (2)) and heats of formation in our composition calculations. This is a realistic approach to the problem of calculating the compositions of gas mixtures containing many complex species, since often the isomeric composition is (as here) not of great interest, and generally the thermodynamic quantities differ little among isomers with the same chemical formula (cf. Ref. 12, pp. 44 and 45). A complete listing of the fit coefficients used (Eqs. 1 and 2) are given in Appendix B, before the results of the composition calculations.

TABLE 1

SPECIES CONSIDERED IN THE COMPOSITION CALCULATIONS.

Species (Chemical formula)	Thermodynamic data Source (Footnote No.)	Remarks (Footnote No.)
C(g)	1	8
H	1	8
H_2	1	8
CH	1	8
CH_2	1	8
CH_3	1	8
CH_4	1	8
C_2	1	8
C_2H	1	8
C_2H_2	1	8
C_2H_3	2	9
C_2H_4	1	8
C_2H_6	2	9
C_3	3	8
C_3H	2	9
C_3H_2	2	9
C_3H_3	2	9
C_3H_4	2	9, 10
C_3H_5	2	9
C_3H_6	2	9, 11
C_3H_8	2	9
C_4	1	8
C_4H	2	9
C_4H_2	2	9

TABLE 1 (Cont'd.)

C_4H_3	2	9
C_4H_4	2	9, 11
C_4H_5	2	9, 11
C_4H_6	2	9, 11
C_4H_8	2	9, 11
C_4H_{10}	2	9, 11
C_5	1	8
C_5H	2	9
C_5H_2	2	9
C_5H_3	2	9
C_5H_4	2	9, 11
C_5H_6	2	9
C_6	2	9
C_6H	2	9
C_6H_2	2	9
C_6H_3	2	9
C_6H_4	2	9, 12
C_6H_6	2	9
C_7	2	9
C_7H	2	9
C_7H_2	2	9
C_8	2	9
C_8H	2	9
C_8H_2	2	9
C_9	2	9
C_9H	2	9
C_9H_2	2	9

TABLE 1 (Cont'd.)

C_{10}	2	9
$C_{10}H$	2	9
$C_{10}H_2$	2	9
e^-	1	8
C^+	4	9
C^-	1	8
H^+	1	8
H^-	1	8
H_2^+	5	—
H_3^+	5	—
CH^+	6	13
CH_3^+	7	8
C_2^-	1	8
C(s; graphite)	1	8

Footnotes to Table 1

1. Tabular data and $\Delta H_f(T = 0^\circ K)$ taken from JANAF Thermochemical Tables, The Dow Chemical Company, Midland, Michigan (August, 1965), and from the first and second addendums thereto, dated, respectively, August, 1966, and August, 1967. The most recent of the data given in this reference has been used for each species.

2. Fit coefficient data and $\Delta H_f(T = 0^\circ K)$ taken from R. E. Duff and S. H. Bauer, The Equilibrium Composition of the C/H System at Elevated Temperatures. Los Alamos Scientific Laboratory Report LA-2556 (June, 1961), including corrections of errors given in Table VI (p. 49) of that work.

3. Tabular data taken from H. L. Strauss and E. Thiele, J. Chem. Phys. 46, 2473 (1967). The value for $\Delta H_f(T = 0^\circ K)$ is taken from the reference of Footnote 1 (above).

4. Fit coefficient data and ΔH_f (T = 0° K) taken from P. R. Smith, W. G. Vulliet, and W. B. Lindley, Predictions of Thermal Damage in Nuclear Fireballs. II. Material Properties. U. S. Air Force Flight Dynamics Laboratory Report AFFDL-TR-66-45, Vol. II (June, 1966), p. 3.

5. Tabular data and ΔH_f (T = 0° K) taken from R. W. Patch and B. J. McBride, Partition Functions and Thermodynamic Properties to High Temperatures for H_3^+ and H_2^+. NASA TN D-4523 (April, 1968). These data were fitted over the temperature range 1000 - 10,000°K.

6. Tabular data and ΔH_f (T = 0° K) hand-calculated by the present author (cf. Appendix A), and fitted for the temperature range 1000 - 10,000° K.

7. Tabular data taken from D. G. Clifton, Approximate Thermodynamic Functions for the $H_3O^+(g)$, $HCO^+(g)$, and $CH_3^+(g)$ Ions. General Motors Corporation Defense Research Laboratories Report TR64-02D (July, 1964). ΔH_f (T = 0° K) = 259.7 kcal/mole calculated by the present author using the value of this quantity for CH_3 (32.8 kcal/mole) from the reference of Footnote 1(above) and a CH_3 first ionization potential of 9.84 ev, as given in W. C. Price, "Potentiels d' ionisation moléculaires déterminés spectroscopiquement.", Annexe I to B. Rosen, "Spectroscopie électronique moléculaire," in S. Flügge (ed.) Handbuch der Physik XXVII, Springer, Berlin (1964).

8. The tabular thermodynamic data were given only up to T = 6000° K. We have used our fourth-order polynomial fits to these data for the range 1000 - 6000° K up to the highest temperature (T = 10,000° K) in the present composition calculations.

9. The fit coefficient data given in the pertinent reference were for the range T = 1500 - 6000° K, inclusive, and these were applied here up to the highest temperature (T = 10,000° K) in the present composition calculations.

10. Grouping of isomers and "average" fit coefficients and heats of formation were used, per Table V (p. 48) of the reference of Footnote 2 (above).

11. Fit coefficients for selected isomers of Table IV (pp. 44 - 45) of the reference of Footnote 2 (above) were adopted in the present composition calculations, as follows:

Species	Selected isomer	Line in Table IV
C_3H_6	Propene	55
C_4H_4	vinyl acetylene	43
C_4H_5	$CH_2\overset{H}{C} = C = CH_2$	53
C_4H_6	1,3 butadiene	59
C_4H_8	trans-2-butene	67
C_4H_{10}	isobutane	70
C_5H_4	$HC \equiv CC \equiv CCH_3$	45

12. For C_6H_4 we have used the fit coefficients given in line 48 of Table IV (pp. 44 - 45) of the reference of Footnote 2 (above), with the corrections given in the "Note" to Table IV (p. 48) of that reference.

13. See Appendix A of the present report for a discussion of these data.

For the species C_3 we have used the latest thermochemical data (cf. Table 1), which is based on the recently-discussed very low bending frequency of this radical, although this has been questioned[13]. For CH^+ we have hand-calculated the thermodynamic functions (Appendix A).

Condensed Phases

There is, due to the temperature and pressure range considered, the possibility that carbon will condense in the mixtures of interest. This possibility can be considered by the HUG computer program for a single condensed phase. The HUG program assumes that the condensed phase has a constant molar volume over the temperature and pressure ranges considered in the equilibrium composition calculations, and it ignores the small effects of pressure on the enthalpy and chemical potential of the condensed phase. With these assumptions, the HUG program attempts to

satisfy the equilibrium conditions assuming that the condensed phase is present; when unable to do so, it is determined that the mole number of the condensed phase is zero. For the conditions of interest here there is the possibility that carbon may condense in either solid or liquid form (or both). We have the requisite thermodynamic functions only for solid carbon (graphite), and we can consider only this species in the computer calculations of compositions. For liquid carbon, the available literature data will permit us to estimate whether the partial pressure of condensable carbon, which is the partial pressure of the species C_n ($n = 0 \rightarrow 10$), in our case, is ever sufficiently large in the mixtures of interest to yield possible condensation to liquid carbon. The triple point of carbon occurs at 4225° K and 103 atm[14], and the critical point is estimated to be at about 7000° K and 10,000 atm.[15]. Recent work has defined the solid-liquid equilibrium line above the triple point[14, 16]. On the basis of the low C/H mass ratio and the total gas pressures to be considered, we would expect that liquid carbon will not occur in any of them. We give in the "Discussion of Results" section immediately below our evaluation of this problem; any condensed carbon that might be present in the mixtures considered is not to be considered in the calculations of their optical constants.

Discussion of Results

We give both tabular and graphical presentations of the results of the computer calculations of the compositions of the carbon-hydrogen mixtures considered. The print-out of the HUG computer program is given as Appendix C to this report, and a hand-plot of some of this is given in Figure 1.

Probably the most significant result of the HUG composition calculations is that no solid carbon (graphite) was found in any of the mixtures considered. This is due to the low initial mole fraction (about $4. \times 10^{-4}$ to $4. \times 10^{-3}$) of carbon in these mixtures, which assures that the partial pressure of considerable species, C_n ($n = 0 \rightarrow 10$), will always be much less than the partial pressure necessary for condensation at that temperature, even though these condensable species may contain nearly all the carbon nuclei present, as at the higher temperatures considered. The condensable species never have a collective partial pressure that is greater than about one atmosphere, and we conclude on the basis of the available literature data [14, 15, 16], that no liquid carbon can exist

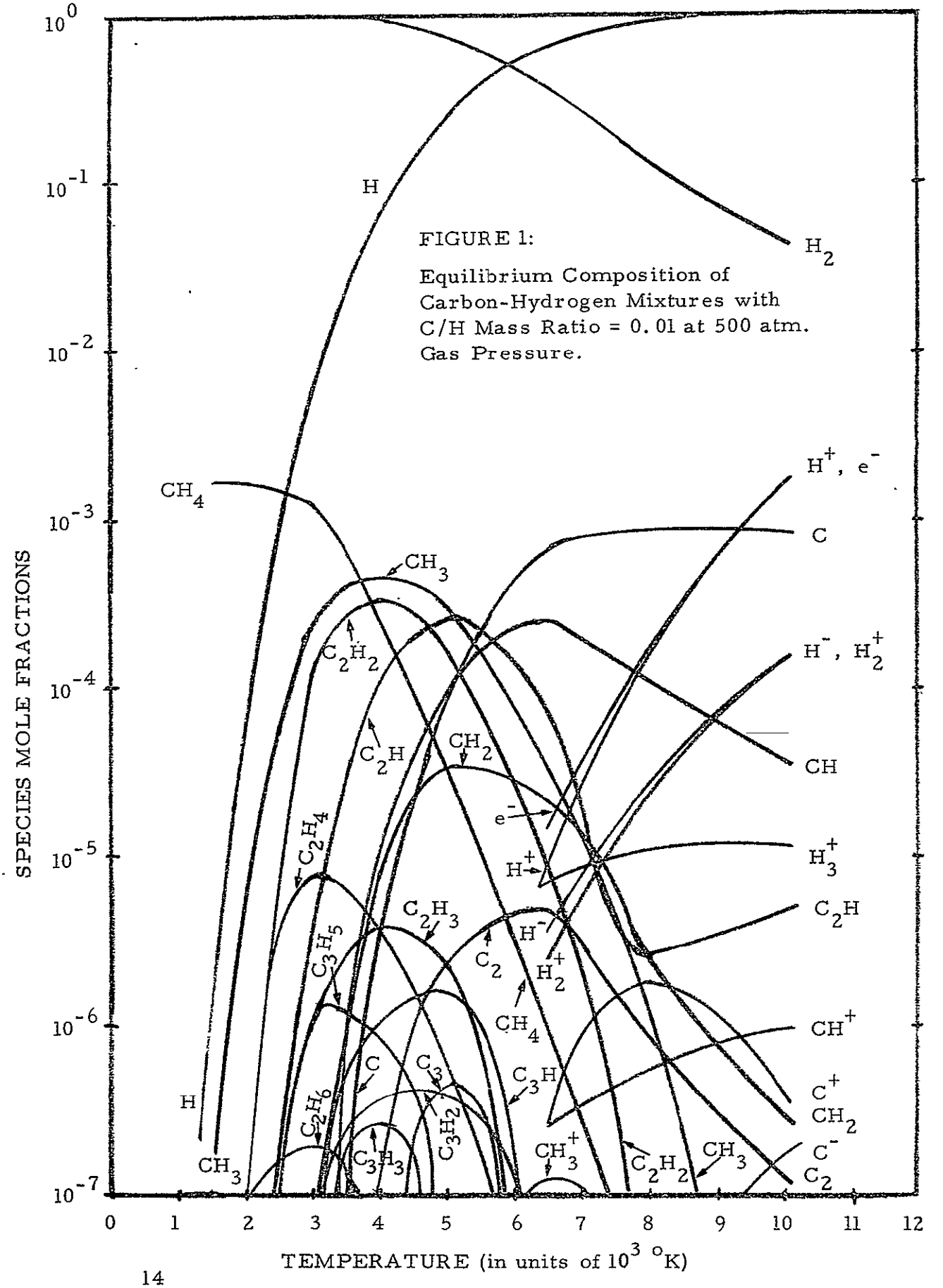

FIGURE 1:

Equilibrium Composition of Carbon-Hydrogen Mixtures with C/H Mass Ratio = 0.01 at 500 atm. Gas Pressure.

in the mixtures considered (the triple point of carbon being at 4225° K and 103 atmospheres[14]). Thus we state rather confidently that no condensed carbon, either graphite or liquid, exists in the carbon-hydrogen mixtures considered.

We find from the computer calculations (Appendix C) that the compositions of the mixtures are not greatly sensitive to the total gas pressure for the pressures considered, and that for each of the temperatures considered the mole fractions of most of the carbon-containing species scales approximately with carbon-hydrogen mass ratio, while the pure hydrogen species (e.g., H and H_2) have mole fractions at each temperature that are largely independent of the C/H mass ratio and total gas pressure. This we would expect for the low C/H mass ratios and pressure range considered. The compositions change rather markedly with temperature, however (Fig. 1). The mixtures considered are largely H_2 and CH_4 at the lowest temperatures, and C, H, H_2, H^+, and free electrons at the highest temperatures. At the intermediate temperatures, the species CH, CH_2, CH_3, C_2H, and C_2H_2 also become important constituents. The mole fraction of free electrons in the mixtures considered is never much greater than 10^{-3}, on account of the high ionization energies of all important species and the relatively high gas pressures considered, and is nearly independent of the C/H mass ratio.

The composition data for the species C, H, H_2, CH, CH^+, C_2, CH_2, CH_3, C_2H, C_2H_2, C_2H_4, C_3, C_6H_6 - benzene, e^-, C^-, and H^-, are input to the OPSAB computer program, which calculates the optical constants of the mixtures. From the data of Appendix C (and from Fig. 1), we see that we have included all of the major species in the calculations of the optical constants, and also one species (C_6H_6 - benzene) which has a very small mole fraction for all of the mixtures considered.

Based on the results of our composition calculations, we conclude that since all of the very complex species considered have small mole fractions for all of the conditions considered, that we probably make little error in having neglected some of the other complex species that might have been considered in our composition calculations. We believe that all species that might have mole fractions of 10^{-6} or more under any of the conditions considered have been included in our composition calculations.

Also, we believe that we had correctly selected the species to be considered in the calculations of the optical constants, excepting for a very few species (e.g., C_2H_3) which were not so selected due to lack of the necessary quantitative spectroscopic data, and excepting C_6H_6, which proved to have a very small mole fraction in all the mixtures considered, and could have been neglected in the calculations of the optical constants. The species to be considered in the calculations of the optical constants were originally selected in advance of the performance of the composition calculations, and it was not felt necessary to change this original selection on the basis of the composition calculations. This will be discussed further in the section on the calculations of the optical constants, but we note here that we feel only that the results for the optical constants show that certain species could have been safely neglected in their calculation.

Uncertainties in the Composition Calculations

There are some errors inherent in the calculations of the species composition, partly due to uncertainties in the ideal gas thermochemical functions and heats of formation of the more complex species. Also, some of the more complex species can exist in several isomeric forms, which have somewhat different thermochemical functions and heats of formation, and this has not been precisely taken into account here (cf. above.) Uncertainties here can also be caused by omission of important species from the calculations, but in addition, for the conditions of interest, we may have pressure dissociation effects, pressure ionization effects, ionization potential lowering by Coulomb interactions, non-ideal gas equation-of-state effects, and collective influences on the basic thermochemical properties of the system.

We believe that uncertainties in the ideal gas thermochemical functions and heats of formation give rise to little error in our composition calculations, since these are probably reasonably accurate for the lighter species (except possibly for C_3[13], which always has a small mole fraction, however); the more complex species have small mole fractions for all of the conditions considered, and thus any reasonable errors in their thermochemical functions or heats of formation, including those due to "averaging" over isomers with the same chemical formula, should have a rather small effect on the computed mole fractions of the major components of the mixtures

considered, and therefore a small effect on the computed optical constants.

We have already shown why we are confident that no condensed carbon, either graphite or liquid, exists in the mixtures considered. We have also commented above that we felt that all important species had been considered in the composition calculations. Consideration of the further sources of uncertainties in the composition calculations that are mentioned above is more difficult, but we take up these questions here so far as we are able.

Pressure dissociation effects in molecular hydrogen gas have been considered by Vardya[17]. His approximate analysis does not apply perfectly to the carbon-hydrogen mixtures considered here, but we can obtain from his work an estimate of the magnitude of such effects for these cases. These we find to be small for the temperatures and pressures considered here. For a mixture of H and H_2 at a total gas pressure of order 1000 atmospheres and gas temperatures of order 6000° - $10,000^\circ$K, pressure dissociation alters the mole fraction (and therefore number density) of H_2 by no more than about 5.%. For hydrogen gas, pressure dissociation becomes greatly important only at much higher total gas pressures than those considered here, according to the predictions of Vardya[17]. We assume that this is also true for the carbon-hydrogen mixtures considered here, although this effect could be quite different in these cases. Pressure ionization should not be of importance here, since it can occur effectively only when the mean separation of atoms and molecules is much less than that of the solid or liquid material, or, equivalently, when the mass density of the gas is greater than that of the solid or liquid material. The greatest mass density of the gas mixtures considered here is approximately 0.01 gm-cm^{-3}, which is less than the densities of either liquid or solid hydrogen (0.07 and 0.076 gm-cm^{-3}, respectively [18], or of liquid or solid carbon (about 2 to 3 gm-cm^{-3}, depending upon the condensed form[18]). We conclude that the density regime of pressure ionization is not approached in the mixtures we have considered, and that this phenomenon is safely neglected here.

The effect of Coulomb interactions among charged particles in the carbon-hydrogen mixtures considered is to effectively decrease the ionization potentials of all species present, thus increasing the degrees of ionization of the mixtures. For the mixtures considered

here, the Debye screening lengths, d, found from

$$d^2 = \frac{kT}{4\pi e^2 N_i} , \tag{3}$$

with k the Boltzman constant, e the electronic charge, T the temperature (°K), and N_i the ionic number density, are of the same order of magnitude as the mean atomic (molecular) separations, i.e., about 10^{-7} cm. This means that Coulomb-interaction effects should be of such magnitude that they could alter, but probably only slightly, the calculated gas mixture composition from the case where Coulomb effects are ignored. We find this to be a slight effect here, for comparing our composition results with those of Patch[19] for pure hydrogen, which includes the effects of Coulomb interactions, we find that our results for the concentrations of H^+, H^-, H_2^+, H_3^+, and e^- agree with his to within a few percent for all cases where we have both considered the same temperatures and total gas pressures. The small differences found may be due entirely to the presence of carbon in our gas mixtures, rather than to Coulomb-interaction effects, and we believe that Coulomb interactions affect the compositions of the gas mixtures considered here at most very slightly for this reason. A slight lowering of the ionization potentials of the species generally can affect the degree of ionization markedly, but the optical constants of the mixture should be affected only slightly by a small reduction here.

Let us compare the approximate Coulomb interaction energy density to the thermal translational energy density for the gas mixtures considered here. If N_e and N_i are the number densities of free electrons and ions, respectively, then the mean separation of charged particles in the gas, 2r, is approximately given by

$$\frac{4}{3}\pi r^3 = \frac{1}{N_e + N_i} . \tag{4}$$

For the mixtures which we have considered, $N_e + N_i$ is never much greater than 10^{18} cm^{-3}(or about 0.003 of the total particle density), so that 2r is never less than about 10^{-6} cm. The Coulomb interaction energy per charged particle, for singly-charged particles, is then not greater than $e^2/2r \cong 0.1$ ev, where e is the electronic charge, while the mean translational energy of the individual particles is nearly 1 ev at 10,000° K, where the quantity $N_e + N_i$ has its

maximum values. The Coulomb energy density in the gas mixtures considered here, weighted by the ionization levels found, is then only about 0.0003 of the translational energy density in the worst cases, and need not be taken into account in the equation of state of these gas mixtures. The effects of the Coulomb interactions are to decrease the pressures and energy densities of the gas mixtures (since the Coulomb forces will be predominantly attractive in a gas that is electrically neutral overall) compared to the values for these properties predicted neglecting Coulomb interactions. On the other hand, the lowering of ionization potentials will tend to increase the gas pressure and energy density through the liberation of additional free electrons. These effects can, at times, counterbalance one another, and we infer, from the above arguments and from the close agreement of our results with those of Patch[19] for hydrogen based on the Debye-Hückel equation of state, that the net effect of Coulomb interaction on our computed compositions is quite small. We believe for the same reason that the related effect of Stark-type shifting of energy levels will not effect our composition results more than very slightly. This effect was ignored by Patch[19] in his calculations for hydrogen gas under conditions of temperatures and pressures including those considered here, and he noted that the available evidence indicates that these shifts are small for these conditions.

We have noted above that the maximum mass density of the mixtures considered is about 0.01 gm-cm^{-3}, or about 1/7 of the mass density of liquid or solid hydrogen. This also implies that the mean separations of atoms or molecules in the gas mixtures considered are somewhat greater than those which can produce condensation. This being the case, we presume that interactions between neutral particles in the gas mixtures considered produce errors in the thermodynamic functions used (which are for independent, non-interacting, particles) in our composition calculations are probably in error by no more than 10 - 15% or so due to neutral particle interactions. Such errors are, in many cases, of the same order as the errors due to uncertainties in the spectroscopic constants and approximate models and formulae used to calculate the thermodynamic functions used. We expect that neutral particle interaction effects are not severe in the gas mixtures considered, and for the same reason, we presume that the ideal gas equation of state, which was presumed in our composition calculations, may be used without virial corrections.

We can consider, however, the approximate magnitude of the virial corrections to the equation of state for the case of pure molecular hydrogen under the conditions of greatest density encountered here. The virial equation of state may be written[20]

$$\frac{PV}{RT} = 1 + B'(T)\,P + C'(T)\,P^2 + D'(T)\,P^3 + \ldots, \qquad (5)$$

where P is the gas pressure, V its volume, T its temperature, R the universal gas constant, and $B'(T)$, etc., are the first, etc., virial (pressure) coefficients. For $T = 1600°K$, we find for molecular hydrogen[21] that $B'(1600) \cong 1.2 \times 10^{-4}$ atm^{-1} and $C'(1600) \cong 3.2 \times 10^{-9}$ atm^{-2}. For P = 1000 atm, then we find that $PV/RT \cong 1.12$, so that there is about 12.% deviation from the ideal gas equation of state. This agrees well with the discussion of Patch[19], and we assume that such effects have a small, but not entirely insignificant, effect on our composition calculations. Like Patch [19], we have ignored virial corrections to the equation of state in our calculations, owing to the fact that it is impossible to estimate the virial coefficients for all of the significant constituent species of the mixtures that we have considered.

The virial effects on the thermodynamic functions are probably quite small. The deviation of the dimensionless enthalpy function from its ideal gas value may be expressed as [22]

$$\Delta\left[\frac{H_T - H_0}{RT}\right] = \frac{1}{V}\left[B(T) - T\,\frac{dB(T)}{dT}\right] + \frac{1}{V^2}\left[C(T) - \frac{1}{2}\,T\,\frac{dC(T)}{dT}\right] + \ldots, \qquad (6)$$

where all of the quantities have been previously defined, excepting B(T) and C(T), which are the first and second (volume) virial coefficients. For H_2 we find[21] for $T = 1600°K$ that $B(T) - T\,dB(T)/dT \cong 17.8$ cm^3-mole^{-1} and $C(T) - T\,dC(T)/dT \cong 270$ cm^6-mole^{-1}. One mole of gas at $T = 1600°K$ and P = 1000 atm occupies a volume of about 130 cm^3, so that

$$\Delta\left[\frac{H_T - H_0}{RT}\right] \cong 0.15$$

The ideal gas value for H_2 at T = 1600° K is[23] $(H_T^o - H_0^o)/RT = 3.6$ mole^{-1}, so that the virial correction is approximately 4. %. This correction is probably of the same order as the errors in the ideal gas thermodynamic functions for H_2 due to the approximate models used in their computation, and can be safely ignored. Errors of this magnitude should not significantly affect our composition calculations.

We must point out that the errors of 15% and less arising from our use of the ideal gas equation of state can affect the calculations of the optical constants by approximately these same amounts, since there the ideal gas equation of state is used to calculate species number densities from the mole fractions computed for them, in the composition calculations. The errors arising from the several sources mentioned above may tend to cancel one another in some cases, but generally we can expect that maximum errors probably about 10. - 20% can occur in the optical constants from these sources. Such errors are not serious when compared to errors from other sources in the calculations of the optical constants, as will be discussed below in the detailed evaluation of the inaccuracies in the optical constants.

Collective influences on the thermodynamic functions of the mixtures considered should be relatively small, as the above arguments indicate. The thermodynamic functions used here, and in nearly all composition calculations of the present type, are for particles which do not interact with one another except through the chemical forces which cause them to aggregate to form more complex species, or through the electrostatic forces which cause them to become ionized or de-ionized. Thermodynamic functions which take into account all possible other interactions should not yield composition results greatly different than those found here, since the conditions of temperature and pressure considered are not in the regime where collective effects are really important.

CALCULATIONS OF OPTICAL CONSTANTS

The Opacity and Spectral Absorption Computer Program

The Opacity and Spectral Absorption Computer Program (OPSAB)[24] was written at Heliodyne Corporation by Arthur A. Anderson and Roger P. Main in 1966. There has been a continual

improvement of this program since that time. To date this program has been used to compute spectral absorption coefficients and opacities of fluorocarbon-air mixtures[4], of the thermal decomposition products of phenolic carbon and phenolic silica in air and argon[5], and of selected molecules that have been of interest to us in our experimental studies of the optical properties of high-temperature gases and gas-condensed phase mixtures (e.g., BeO, MgO, and SiO).

The OPSAB program gives local Planck mean spectral absorption coefficients, spectral volume emission, and several spectrally-integrated opacities for equilibrium gas mixtures composed of free electrons, atoms, their ions, and molecules and molecular ions, when the gas mixture species composition is known. The program is heavily concerned with electronic transitions in molecular species, and this fact serves to define the ranges of temperature, gas pressure, and spectral frequency that may be considered. No consideration is given in the program to radiative absorption by condensed matter, for which a separate analysis is required. The composition of the gas mixture to be considered by this program must be known from separate calculations. The range of total gas pressures of the mixtures that may be considered is limited at the lower end by the requirement of equilibrium and at the upper end by pressure effects, collective radiative effects, and formation of molecular complexes whose radiative properties are not taken into account in this program. The OPSAB program is limited roughly to pressures in the range 10^{-6} - 10^{4} atmospheres and temperatures in the range 1000 - 15,000° K. The radiative absorption mechanisms considered in the OPSAB program are:

a. Electronic transitions in diatomic, triatomic, and polyatomic molecules.

b. Photodetachment from O^-, C^-, H^-, and F^- ions (only C^- and H^- are of interest in the present work).

c. Free-free transitions of electrons in the fields of neutral and ionized species.

d. Radiative association of hydrogen atoms by the process

$$H(1s)^2S + H(1s)^2S \quad b\ ^3\Sigma_u^+ + h\nu \rightarrow H_2(a\ ^3\Sigma_g^+)$$

e. Photoionization of neutral O, N, C, and H-atoms (only C and H atoms are of interest in the present work)

An essential feature of the program is its basic input data card deck containing all the necessary spectroscopic constants, Franck-Condon factors, and oscillator strengths for electronic transitions in diatomic molecules, and characterization parameters for electronic transitions in polyatomic molecules. The present deck is adequate for C-H-N-O-F gas mixtures for the conditions defined above, and for other gas mixtures for limited sets of conditions. For example, the program and data deck were found adequate for calculation of spectral absorption coefficients of the missile re-entry heat shield material phenolic silica mixed with air and argon for temperatures of 3000 - 5000° K in the wavelength range 3000 - 6000 Å, since for this C-H-N-O-Si gas mixture, and spectral range, the Si-containing species are unimportant in absorption[5].

This program has evolved from programs used by the present author in earlier studies of opacities of carbon-air mixtures[1], hydrocarbon-air mixtures [2, 3], thermally decomposed missile heat shield materials[3], and of Martian and Venusian atmospheric entry radiative heat transfer (unpublished). The present program is not unlike those that have been used by others for calculations of a more restricted nature [25, 26, 27].

The OPSAB program computes locally-averaged (Planck mean) spectral absorption coefficients for the processes named above for input conditions of temperature, pressure, and gas species composition (mole fractions). The lower and upper bound spectral frequencies and the spectral averaging interval for the calculations are specified in the input data, subject to the dimensional requirement that the number of spectral averaging intervals not exceed 36. Electronic transitions in diatomic molecules are treated by the "just-overlapping rotational line" model (equivalent to the "smeared line" model) of Patch, Shackleford, and Penner[28]; electronic transitions in triatomic and polyatomic molecules are treated by a simpler model which includes a "smearing-out" of the vibrational structure of the transitions[2]. Photodetachment and photo-ionization absorption is computed using published cross section data, and the free-free absorption is computed using the Kramers classical formula with unit Gaunt factor. An approximate method ("effective Z^2") is used to extend the free-free absorption calculations to transitions in the fields of neutral species. The H + H radiative association continuum absorption is computed using the model proposed by Erkovitch[29], as corrected by later works (cf. discussion to be given below).

A number of spectrally-averaged opacities listed below are given by the program, in addition to the local Planck mean absorption coefficients. The program also computes spectral emission intensities and the total emitted intensity of optically thin plane layers of gas; it can also modify the computed spectral absorption coefficients and emission intensities to take account of detailed balancing of radiative processes in the "optically thick" limit. The program also computes the opacities for several "weighting temperatures" that can be different from the gas temperature. Only the Planck and Rosseland mean absorption coefficients are required in the present work, however.

Listing of Spectrally-Averaged Opacities
Computed by the OPSAB Program:

a. **Planck mean opacity (cm^{-1}):**

$$\bar{\mu}_P(T,T_R) = \frac{\int_{\omega_o}^{\omega_E} \mu'_\omega(T) B_\omega(T_R)\, d\omega}{\int_{\omega_o}^{\omega_E} B_\omega(T_R)\, d\omega}$$

b. **"Mean-squared Planck mean opacity":**

$$\bar{\mu}_P^{(2)}(T,T_R) = \frac{\int_{\omega_o}^{\omega_E} [\mu'_\omega(T)]^2 B_\omega(T_R)\, d\omega}{\int_{\omega_o}^{\omega_E} B_\omega(T_R)\, d\omega}$$

c. **Rosseland mean-free-path (cm):**

$$\Lambda_R(T,T_R) = \frac{\int_{\omega_o}^{\omega_E} \frac{1}{\mu'_\omega(T)} \frac{\partial B_\omega(T_R)}{\partial T_R}\, d\omega}{\int_{\omega_c}^{\omega_E} \frac{\partial B_\omega(T_R)}{\partial T_R}\, d\omega}$$

d. Reciprocal Rosseland mean-free-path (cm^{-1})(or Rosseland mean opacity):

$$\bar{\mu}_R(T,T_R) = \frac{\int_{\omega_o}^{\omega_E} \frac{\partial B_\omega(T_R)}{\partial T_R} d\omega}{\int_{\omega_o}^{\omega_E} \frac{1}{\mu'_\omega} \frac{\partial B_\omega(T_R)}{\partial T_R} d\omega} = \frac{1}{\Lambda_R(T,T_R)}$$

e. "Mean-squared Rosseland mean-free-path" (cm^2):

$$\Lambda_R^{(2)}(T,T_R) = \frac{\int_{\omega_o}^{\omega_E} \left[\frac{1}{\mu'_\omega(T)}\right]^2 \frac{\partial B_\omega(T_R)}{\partial T_R} d\omega}{\int_{\omega_o}^{\omega_E} \frac{\partial B_\omega(T_R)}{\partial T_R} d\omega}$$

f. I' (cm^2):

$$I' = \frac{\int_{\omega_o}^{\omega_E} \left[\frac{1}{\mu'_\omega(T)}\right]^2 \frac{\partial^2 B_\omega(T_R)}{\partial T_R^2} d\omega}{\int_{\omega_o}^{\omega_E} \frac{\partial^2 B_\omega(T_R)}{\partial T_R^2} d\omega}$$

Here $\mu'_\omega(T)$ is the linear spectral absorption coefficient, (cm^{-1}), including the effects of induced emission, T is the gas temperature, T_R is the "weighting temperature" (equal to the gas temperature, plus as many as five other selected input values), and

$$B_\omega(T_R) = \frac{2\,hc^2\omega^3}{\exp(hc\omega/kT_R) - 1}$$

is the Planck spectral intensity function, with ω the wave number (cm^{-1}),

h the Planck constant (erg-sec), c the speed of light (cm-sec^{-1}), and k the Boltzmann constant (erg-$^{\circ}$K^{-1}). In the present work, T_R was taken to be equal to the gas temperature only.

The basic input data to the OPSAB program for a particular case are the temperature ($^{\circ}$K), the pressure (atm), the spectral range and mixture composition to be considered (the mole fractions of the pertinent species), and the spectroscopic and intensity data for the molecular band systems to be considered. In the present work, the temperatures and pressures are those defined above for the composition calculations, and the spectral range is defined in terms of a dimensionless frequency, u, given by $u = hc\omega/5000k$, with the calculations of the optical constants above for the range limited by u = 2.00 to 19.50, with spectral averaging intervals of width $\Delta u = 0.50$, a total of 35 intervals. We have added an extra interval u = 19.50 - 20.00, to make use of the maximum possible number of 36 averaging intervals, since this improves the accuracy of our calculations for the band systems of diatomic molecules at the highest frequencies. The correspondence of these intervals to wave number intervals (cm^{-1}) is given in Appendix D.

In each spectral averaging interval so defined, the OPSAB program computes the local Planck mean absorption coefficients (cm^{-1}) for the various molecular band systems and absorption processes considered. These are incorporated into sub-total absorption coefficients for the various types of processes, and then these are further incorporated into total local Planck mean absorption coefficients for the case considered; this is used to compute the Planck and Rosseland mean opacities and the other quantities defined above.

The OPSAB program computes the necessary species number densities, N(X) (cm^{-3}), for the absorption processes from the input mole fractions, C(X), from the relation

$$N(X) = C(X)\,(0.73397 \times 10^{22})\,(P/T), \qquad (7)$$

where P is the total gas pressure (atm.) and T is the gas temperature ($^{\circ}$K). These number densities are used to compute the number densities of the molecular species in the absorbing states of the electronic transitions considered via the Boltzmann relation, using the electronic partition functions of the molecules, given as input

to the OPSAB program. The mole fractions used are those calculated by the HUG composition program described above.

Absorption Mechanisms Considered

The absorption mechanisms considered in the OPSAB computer program calculations of the optical constants for the carbon-hydrogen mixtures of the present work has been limited to those incorporated into this computer program as of the commencement of the present work (listed above.) (p. 22). No effort was made to revise this computer program to include additional absorption mechanisms that might have some importance for the conditions considered; the only real significance of this is the exclusion of the H_2 pressure-induced infrared absorption, to be discussed below.

Within this limitation, we have a choice of the electronic band systems of diatomic molecules and of triatomic and polyatomic molecules to be considered in the calculations with the OPSAB computer program. This choice was made in advance of the completion of the composition calculations, with the result that a few of the band systems selected proved to be unimportant for the optical constants. It is believed that all important band systems for which adequate quantitative spectroscopic data exist have been included in the present calculations; some molecular band systems, e.g., those of C_2H, have been included with estimated quantitative spectroscopic data used in lieu of the non-existent laboratory data, on account of their expected importance for the optical constants. Many oscillator strengths of electronic transitions in molecules have been estimated or chosen on the basis of questionable experiments or theoretical calculations, but this is necessary in studies of the present type. We give below listings of the molecular electronic transitions considered in the present work. Table 2 lists the considered transitions in diatomic molecules; Table 3 lists those for triatomic and polyatomic molecules.

The transitions in diatomic molecules are considered in the OPSAB computer program according to the "just-overlapping rotational line" model [28] that is widely used, with an analytic integration scheme, developed by the present author, which yields exactly the local Planck mean absorption coefficients, includint the induced emission correction, for each spectral averaging

interval specified in the input data. This process will not be described here, since it is given in detail elsewhere[24]. The necessary input data for these calculations are the vibrational and rotational constants of the electronic states involved in the transition, the mole fraction of the molecule involved (all electronic states), the electronic partition function of the molecule, the Franck-Condon factors of all the bands to be considered, and the oscillator strength of the electronic transition. Table 2 gives the necessary input data, or the references from which they were taken, for the 16 transitions in the diatomic molecules H_2, CH, CH^+, and C_2, that have been considered in the present work. The latest and/or most accurate data have been used in all cases; this input data was specially prepared for the present work, or was revised from earlier data used by the present author. For further details of the calculations for diatomic molecules, the reader is referred to Ref. 1, which gives a discussion of their application in studies of the present type, and to Refs. 28 and 24, which give the details of them.

Electronic transitions in triatomic and polyatomic molecules are considered on a simplified model which incorporates an "averaging" over their rotational and vibrational structure, assuming one-dimensional simply-harmonic linear oscillations of the nuclei[2, 24]. The spectral absorption cross section evaluated at the $\bar{\omega}$, the mid-points of the spectral averaging intervals chosen, $\sigma'(\bar{\omega}, T)$ (cm^2), including the induced emission correction, for a molecular electronic transition according to the model employed is given by

$$\sigma'(\bar{\omega}, T) = \pi^{1/2} r_o f \left[1-(\exp)(-hc\,\omega/kT) \right] (\Delta\omega_T)^{-1} \cdot \exp \left[-(\bar{\omega} - \omega_o)^2/(\Delta\omega_T)^2 \right], \tag{8}$$

where r_o is the classical electron radius (cm), f is the oscillator strength of the transition, ω_o is the wave number of the transition absorption maximum (cm^{-1}), and

$$\Delta\omega_T = \Delta\omega_o \left[\tanh (\theta_o/2T) \right]^{1/2}. \tag{9}$$

Here $\Delta\omega_o$ is the 1/e half-width of the spectral absorption cross section function at temperature $T = 0°K$, $\Delta\omega_T$ is this width at temperature T(°K), and $\theta_o = hc\,\omega_e''/k$, with ω_e'' the active frequency (cm^{-1}) of the lower (absorbing) electronic state. The OPSAB

program evaluates the function of Eq. (8) and multiplies these by the number density of the absorbing state of the species, which is found from the species mole fraction and the energies and statistical weights of the electronic states of the species in the usual fashion. The resulting "spectrally averaged" absorption coefficients for the averaging intervals chosen are not exactly the local Planck mean values, but are negligibly different from them for averaging intervals of width less than a few thousand wave numbers.

This simplified approach permits simultaneous consideration of a large number (up to 50) of electronic transitions in triatomic and polyatomic molecules for each case considered by the OPSAB program. This model represents a "trade-off" of accurate treatment of the spectral absorption characteristics of the individual transitions, which would be an extremely complicated task, for the possibility of simultaneous treatment of a large number of such transitions, a feat that would be practically impossible using a more accurate model for the spectral absorption of the band systems, but which is usually always necessary for complex gas mixtures, such as those considered here.

The value of ω_o (Eq. (8))is frequently readily chosen as the band system origin, a quantity found in the literature for most transitions of interest. Where large changes in molecular structure accompany the electronic transition, however, the value of ω_o may be significantly different from the origin wave number, and in these cases ω_o must be estimated, preferably with the aid of experimental studies of spectral absorption coefficients of the transition at relatively high gas pressures. The value for $\Delta\omega_o$ must generally be estimated, taking into account what experimental absorption data is available plus the geometries of the electronic states involved in the transitions. The value for ω_e'' is generally chosen to be that of the (most) active vibrational mode, usually known from experiment. The oscillator strengths, f, for electronic transitions in triatomic and polyatomic molecules are generally not well known, and many of these must be estimated or extracted from rather imperfect or qualitative studies reported in the literature.

The state of our knowledge of the quantitative details of electronic spectra of triatomic and polyatomic molecules partly justifies the rather simple treatment that is given them in the OPSAB program. Many estimates of the necessary model parameters

TABLE 2. DIATOMIC MOLECULAR BAND SYSTEMS CONSIDERED

		Print-Out Acronym	Absorption f-value used	Extent of Frank-Condon factor array used
1.	H_2 ($B^1\Sigma_u^+ - X^1\Sigma_g^+$) (Lyman)	H2LYMN	0.30	v'' = 0-14 v' = 0-20
2.	H_2($B'^1\Sigma_u^+ - X^1\Sigma_g^+$)	H2BP-X	0.055	v'' = 0-14 v' = 0-9
3.	H_2 ($C^1\Pi_u - X^1\Sigma_g^+$) (Werner)	H2WERN	0.35	v'' = 0-14 v' = 0-14
4.	H_2 ($D^1\Pi_u - X^1\Sigma_g^+$)	H2 D-X	0.084	v'' = 0-14 v' = 0-10
5.	H_2 ($D^{1\,\prime}\Pi_u - X^1\Sigma_g^+$)	H2DP-X	0.030	v'' = 0-20 v' = 0-10
6.	CH ($A^2\Delta_i - X^2\Pi_r$)	CH A-X	0.005	v'' = 0-7 v' = 0-6
7.	CH ($B^2\Sigma^- - X^2\Pi_r$)	CH B-X	0.002	v'' = 0-7 v' = 0-6
8.	CH ($C^2\Sigma^+ - X^2\Pi_r$)	CH C-X	0.003	v'' = 0-7 v' = 0-6
9.	CH^+ ($A^1\Pi - X^1\Sigma^+$)	CH + A-X	0.004	v'' = 0-10 v' = 0-19
10.	C_2 ($A^3\Pi_g - X'^3\Pi_u$) (Swan)	C2SWAN	0.027	v'' = 0-10 v' = 0-13
11.	C_2 ($A'^3\Sigma_g^- - X'^3\Pi_u$) (Ballik-Ramsay)	C2 B-R	0.0066	v'' = 0-10 v' = 0-16
12.	C_2($b^1\Pi_u - X^1\Sigma_g^+$) (Phillips)	C2PLPS	0.0165	v'' = 0-10 v' = 0-9
13.	C_2 ($B^3\Pi_g - X'^3\Pi_u$) (Fox-Herzberg)	C2 F-H	0.010	v'' = 0-8 v' = 0-8
14.	C_2 ($d^1\Sigma_u^+ - X^1\Sigma_g^+$) (Mulliken)	C2MLK	0.055	v'' = 0-8 v' = 0-8
15.	C_2 ($e^1\Sigma_g^+ - b^1\Pi_u$) (Freymark)	C2FYK	0.010	v'' = 0-8 v' = 0-5
16.	C_2 ($c^1\Pi_g - b^1\Pi_u$) (Deslandres-d'Azambuja)	C2 D-A	0.010	v'' = 0-8 v' = 0-6

Note: The f-values used are based on experimental and theoretical studies analyzed in Ref. 37 and a yet unpublished revision to that work.

TABLE 3. TRIATOMIC AND POLYATOMIC MOLECULAR TRANSITIONS CONSIDERED

DESIGNATION	Print-Out Acronym	Absorption f-value used	ω_o-value used (cm^{-1})	ω_e-value used (cm^{-1})	$\Delta\omega_o$-value used (cm^{-1})
CH_2 ($\tilde{b}\,^1B_1 - \tilde{a}^1A_1$)	CH2 1	0.001 (est.)	7100	3000	6000
CH_2 ($\tilde{c}^1A_1 - \tilde{a}^1A_1$)	CH2 2	0.01 (est.)	27000	3000	4000
CH_3 ($\tilde{B}^2A_1' - \tilde{X}^2A_2''$)	CH3 B	0.01 (est.)	46333	3300	2000
CH_3 ($\tilde{C}^2E'' - \tilde{X}^2A_2''$)	CH3 C	0.1 (est.)	66536	3300	2000
CH_3 ($\tilde{D}^2A_1' - \tilde{X}^2A_2''$)	CH3 D	0.1 (est.)	66799	3300	2000
C_2H ($\tilde{A}^2\Sigma^+ - \tilde{X}^2\Pi$)	C2H A	0.01 (est.)	12000	3300	2000
C_2H ($\tilde{B}^2A' - \tilde{X}^2\Pi$)	C2H B	0.01 (est.)	55000	3300	6000
C_2H ($\tilde{C}^2\Pi - \tilde{X}^2\Pi$)	C2H C	0.1 (est.)	65000	3300	4000
C_2H ($\tilde{D}^2A'' - \tilde{X}^2\Pi$)	C2H D	0.001 (est.)	65000	3300	7000
C_2H ($\tilde{B}^2A' - \tilde{A}^2\Sigma^+$)	C2H 1	0.0001 (est.)	43000	3000	4000
C_2H ($\tilde{C}^2\Pi - \tilde{A}^2\Sigma^+$)	C2H 2	0.001 (est.)	53000	3000	3000
C_2H ($\tilde{D}^2A'' - \tilde{A}^2\Sigma^+$)	C2H 3	0.01 (est.)	53000	3000	4000
C_2H ($\tilde{E}^2\Sigma^+ - \tilde{A}^2\Sigma^+$)	C2H 4	0.1 (est.)	63000	3000	5000
C_2H_2 ($\tilde{A}^1A_u - \tilde{X}^1\Sigma_g^+$)	C2H2 A	0.0001	42198	3300	2000
C_2H_2 ($\tilde{B}(?) - \tilde{X}^1\Sigma_g^+$)	C2H2 B	0.005	59000	3300	2000
C_2H_2 ($\tilde{C}\,(^1\Pi_u) - \tilde{X}^1\Sigma_g^+$)	C2H2 C	0.005	65814	3300	1000
C_2H_4 ($\tilde{A}^1B_{1u} - \tilde{X}^1A_g$)	C2H4 A	0.3	61500	1600	2500
C_2H_4 ($\tilde{B}(?) - \tilde{X}^1A_g$)	C2H4 B	0.04	57336	1600	120
C_2H_4 ($\tilde{C}(?) - \tilde{X}^1A_g$)	C2H4C	0.03	66607	1600	120

Table 3. Triatomic and Polyatomic Molecular Transitions Considered (cont'd)

DESIGNATION	Print-Out Acronym	Absorption f-value used	ω_o-value used (cm^{-1})	ω_e-value used (cm^{-1})	$\Delta\omega_o$-value used (cm^{-1})
C_3 ($\tilde{A}^1\Pi_u$ - $\tilde{X}^1\Sigma_g^+$)	C3 A	0.13	24676	1200	1000
C_6H_6 ($\tilde{A}^1B_{2u}$ - $\tilde{X}^1A_{1g}$) (benzene)	C6H6 A	0.002	38086	995	3000
C_6H_6 ($\tilde{B}$ (?) - $\tilde{X}^1A_{1g}$) (benzene)	C6H6 B	0.10	49100	995	2500
C_6H_6 ($\tilde{C}^1E_{1u}$ - $\tilde{X}^1A_{1g}$) (benzene)	C6H6 C	0.8	55000	995	2000

Note: The absorption f-values marked "(est.)" have been estimated, since experimental data are lacking. The remaining f-values have been taken from Ref. 37, and from a yet unpublished revision to that work.

(Eq. (8)) have been necessary in order to include these spectra in our work, but this is necessary on account of their importance. We give in Table 3 the values of the necessary parameters used in the present work for the 23 transitions in the molecules CH_2, CH_3, C_2H, C_2H_2, C_2H_4, C_3, and C_6H_6, which have been considered.

The photodetachment absorption processes are considered in the OPSAB program using published cross section data [30, 31] for C^-, O^-, H^-, and F^- ions and the mole fractions of these ions. These mole fractions may be input to the program, as in the present work, or can be calculated by the program via the Saha equation from the mole fractions of free electrons and of the neutral species. The cross section data compiled into the OPSAB program are tabular data, taken from the curves given in Refs. 30 and 31; the OPSAB program interpolates in these tabular data to obtain the values of the cross sections at the mid-points of the spectral averaging intervals chosen. No excited states of the negative ions are considered in the calculation of their ground state number densities from the species mole fractions, but the cross section data used include transitions terminating in excited states of the neutral atoms. The interpolation procedure used does not yield exactly the local Planck mean absorption coefficients for the spectral averaging intervals chosen, but there is little error from this fact in the present work, which includes calculations only for the C^- and H^- ions, of course, These calculations are described fully in Ref. 24, and they include the induced emission correction.

The free-free absorption processes are considered in the OPSAB program using Kramers' classical formula with unit Gaunt factor[24]. An effective charge factor, Z^2_{eff}, specifies the interaction strengths for free-free transitions in the fields of singly-ionized (either positively or negatively so) species, taken collectively, or in the fields of neutral species, taken collectively. In the former case we use $Z^2_{eff} = 1$, and in the latter case we use $Z^2_{eff} = 0.02$, a reasonable average value founded upon the most recent studies of the AVCO-Everett Research Laboratory group[32]. Kramers' formula is evaluated at the mid-points of the spectral averaging intervals chosen, using the mole fractions for the (collective) singly-ionic species and for the (collective) neutral species, which are input to the OPSAB program. This yields the values of the spectral absorption coefficients (cm^{-1}) for these two processes at the interval mid-points, which should be negligibly different from the local Planck mean values for the present work; the calculated values include the induced emission correction.

These calculations are fully described in Ref. 24, where the reader is referred for further details. We remark here that many workers neglect the neutral species free-free processes, whereas for conditions approximating those considered here they are roughly of the same importance as the singly-ionic species free-free processes, which are nearly always considered by other workers for such conditions.

The radiative association process for hydrogen atoms defined above (p. 22) has been known for many years, and recent reviews of work on this process have been given by the present author[2] and by Doyle[33]. It is not of great importance here, but has been included for the sake of completeness. This process is considered in the OPSAB program using the model formulated by Erkovitch[29], but with effective collision diameters, d_o, for this process indicated by the later studies of Soshnikov [34] and of Solomon[35]. We have not taken account in the OPSAB calculations the corrections to the works of Erkovitch and of Solomon that have been developed by Zwaan[36] and by Doyle[33], since these do not greatly alter the low degree of importance of this process in the present work. The scheme of the OPSAB calculations is given in Refs. 2 and 24, but we note here that we simply evaluate the Erkovitch formula (adding to it the induced emission correction) for the spectral absorption coefficient (cm^{-1}) due to this process, incorporating the corrected d_o-values and the H-atom number density found from the H-atom mole fractions given by the HUG program composition calculations, at the mid-points of the spectral averaging intervals chosen. These differ little from the local Planck mean values for the present application. The values of d_o used in the present work are given below for reference.

Values of Effective Collision Diameters Used to Calculate Absorption Due to the Hydrogen Radiative Association Continuum

Temperature (°K)	d_o (Å), based on Ref. 35
1600	2.72
2200	2.51
3000	2.33
4000	2.17
5000	2.05
6500	1.92
8000	1.82
10,000	1.72

Analogous radiative association processes should not be important for the other molecules present in the mixtures considered, and, in fact, nothing is known of these if they exist[37]. However, photodissociation processes from the ground states of some of the molecules present have been studied in the literature, and their importance will be discussed below when the accuracy of the calculations of the optical constants is assessed.

The calculations of photoionization absorption for neutral C- and H-atoms are described in some detail in Appendix E. We note here only that these calculations use photoionization cross sections from the literature interpolated at the mid-points of the spectral averaging intervals chosen and the number densities of neutral C- and H-atoms found from their mole fractions given by the HUG composition program, and that these calculations alone do not include the induced emission correction to the computed spectral absorption coefficients, due to an oversight which occurred in the preparation of the OPSAB program sub-routine which performs the computations for these processes. This oversight was noticed only after the present work had been completed, but gives negligible error here.

The OPSAB program sums over these processes to find the spectral absorption coefficient of the gas mixture. This result is used to calculate the opacities and radiative emission parameters described herein (pp. 24-25, and Appendix D). For further details of the quantities computed, the reader is referred to Ref. 24. A discussion of the effect of this choice of optical absorption processes on the accuracy of our results for the optical constants is given in the section following the discussion of the results.

Discussion of Results

The major results of the calculations of the optical constants for the carbon-hydrogen mixtures considered are given in Appendix D to this report; the complete results of these calculations, which include the contributions to the local Planck mean absorption coefficients of each of the molecular band systems and absorption processes considered, has not been given here due to their great length (c. 800 pages)

We give in Figs. 2a - 2f hand-plots of the Planck and Rosseland mean opacities (defined on pp. 24 - 25 of this report) vs. gas temperature for the three pressures and C/H mass ratios considered. These

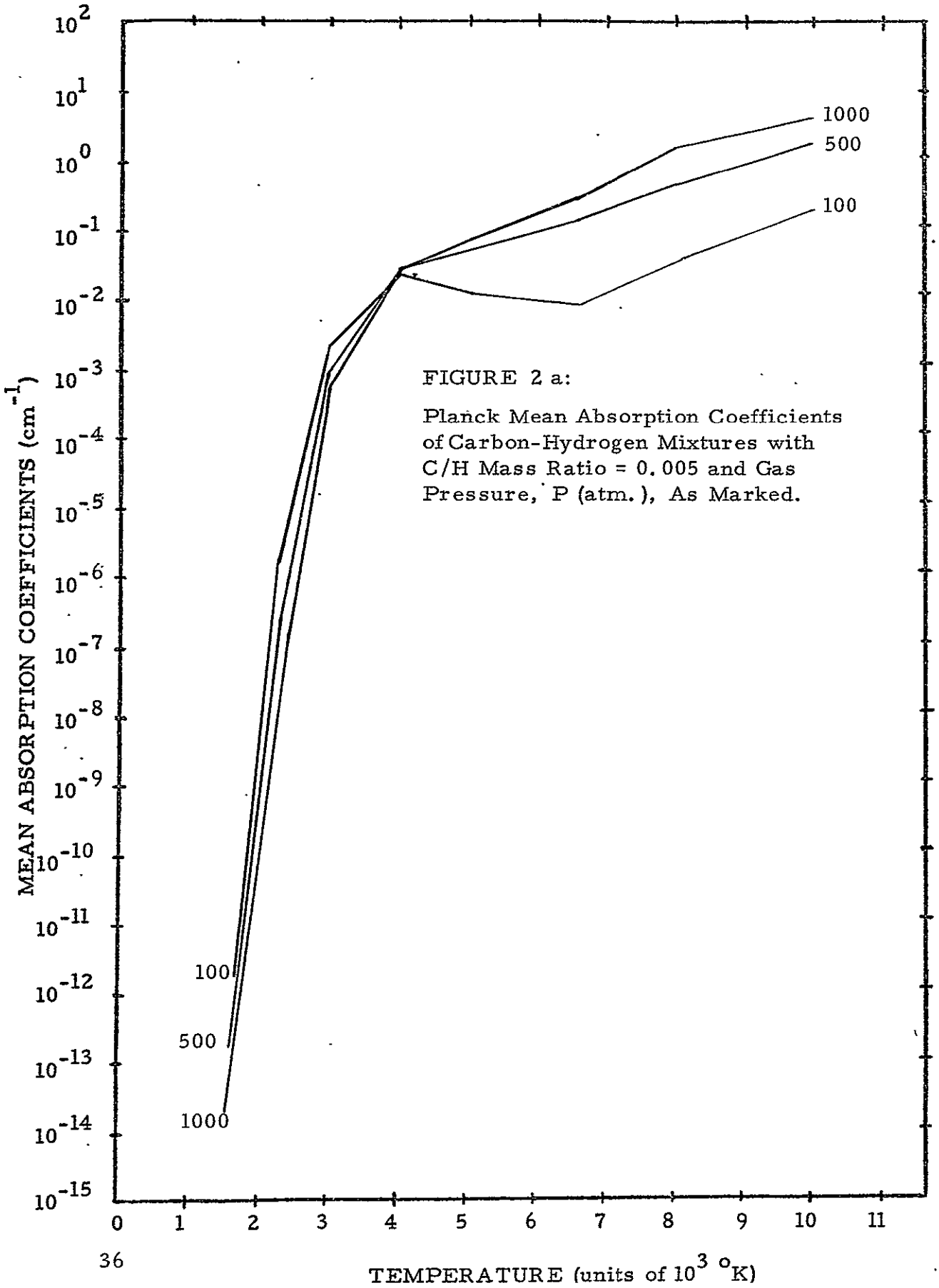

FIGURE 2 a:

Planck Mean Absorption Coefficients of Carbon-Hydrogen Mixtures with C/H Mass Ratio = 0.005 and Gas Pressure, P (atm.), As Marked.

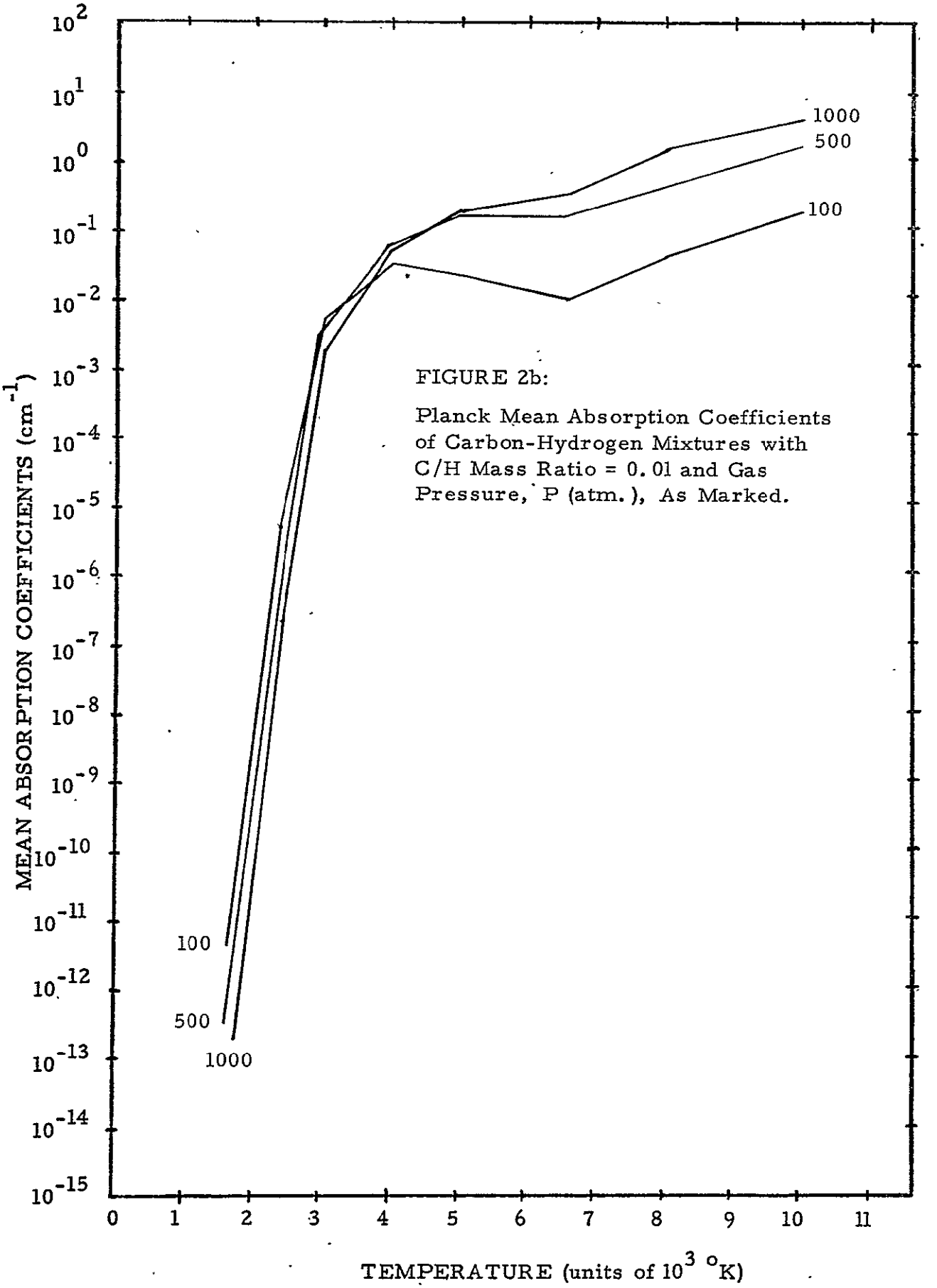

FIGURE 2b:

Planck Mean Absorption Coefficients of Carbon-Hydrogen Mixtures with C/H Mass Ratio = 0.01 and Gas Pressure, P (atm.), As Marked.

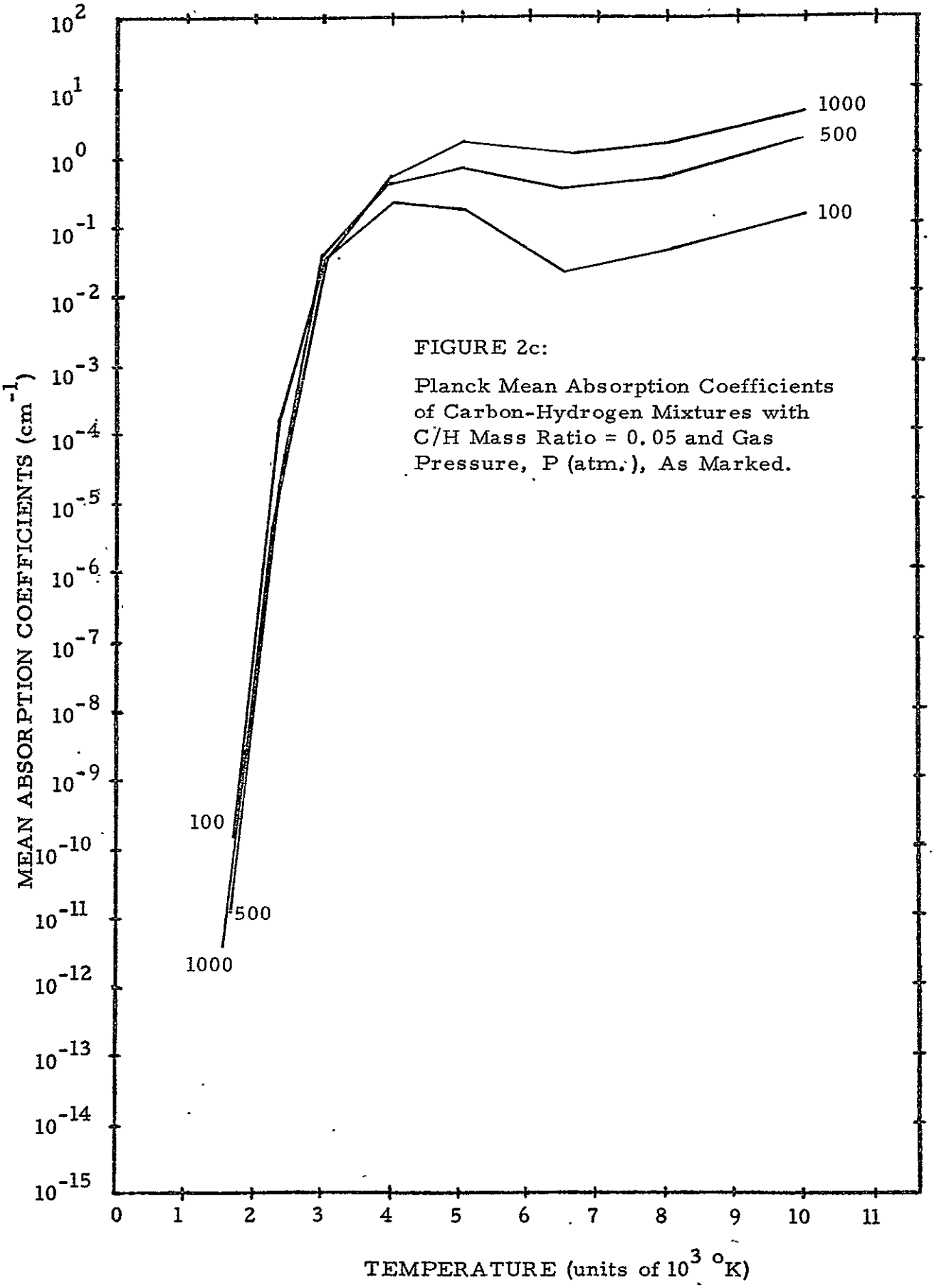

FIGURE 2c:

Planck Mean Absorption Coefficients of Carbon-Hydrogen Mixtures with C/H Mass Ratio = 0.05 and Gas Pressure, P (atm.), As Marked.

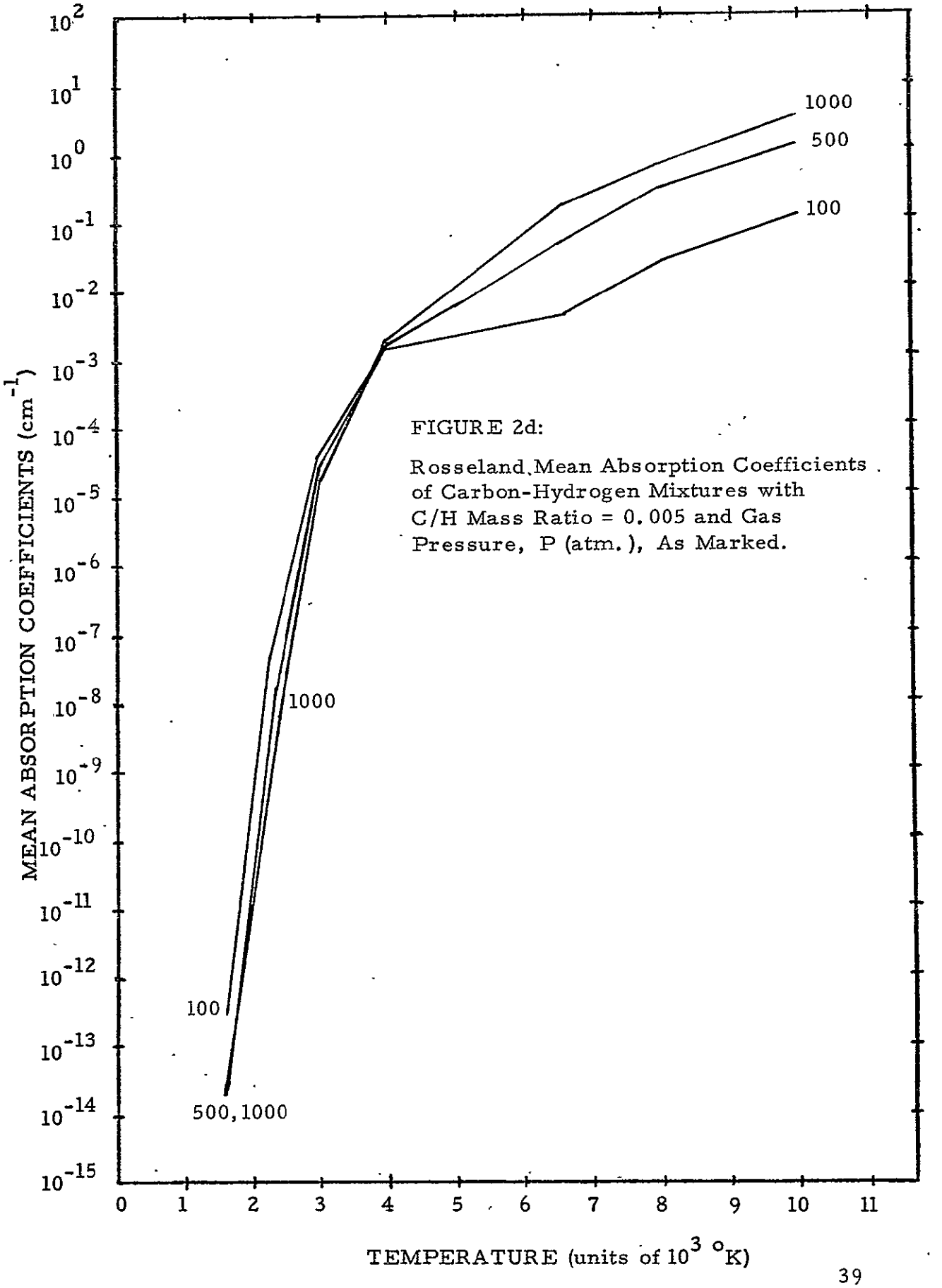

FIGURE 2d:

Rosseland Mean Absorption Coefficients of Carbon-Hydrogen Mixtures with C/H Mass Ratio = 0.005 and Gas Pressure, P (atm.), As Marked.

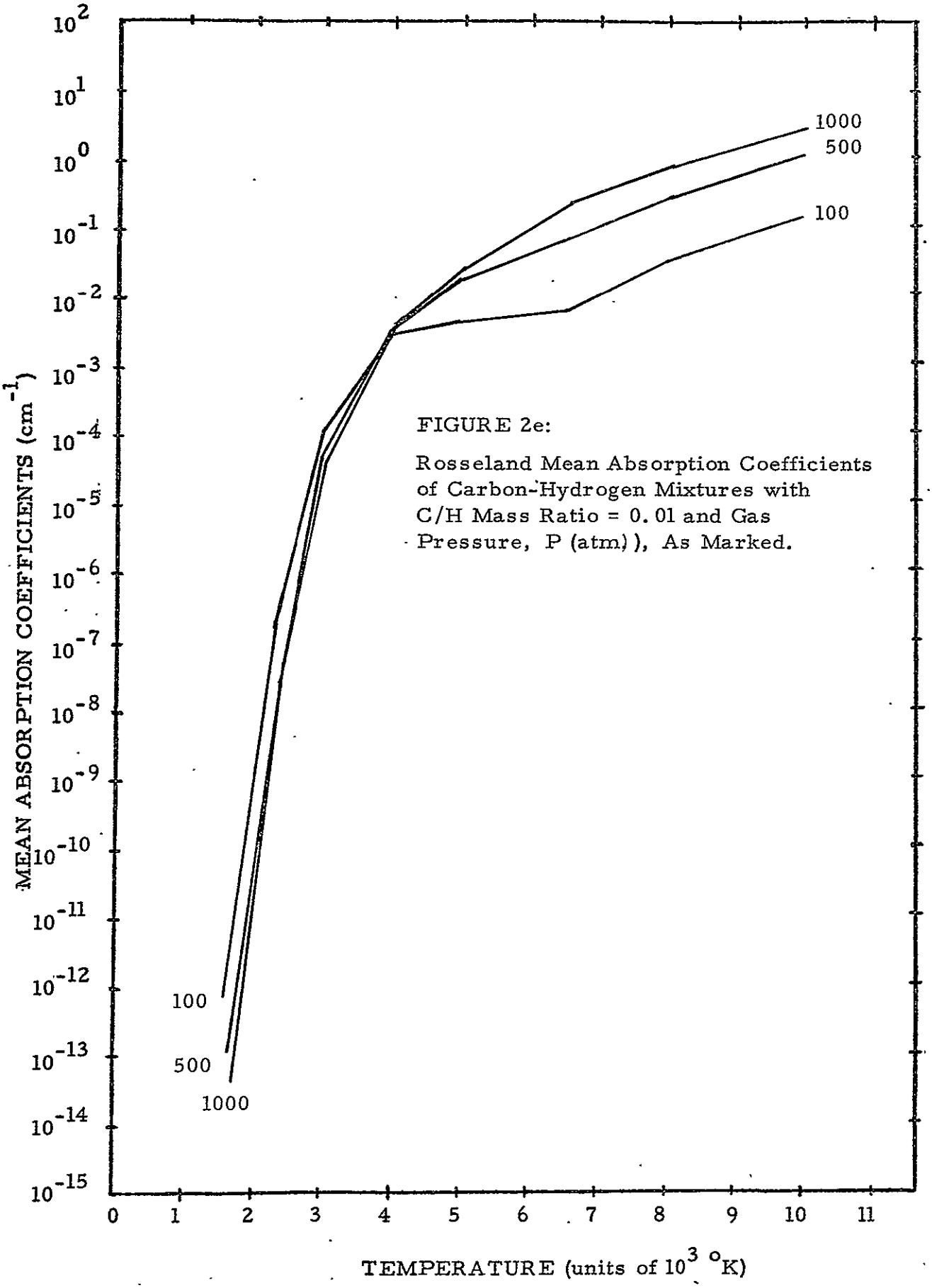

FIGURE 2e:

Rosseland Mean Absorption Coefficients of Carbon-Hydrogen Mixtures with C/H Mass Ratio = 0.01 and Gas Pressure, P (atm.), As Marked.

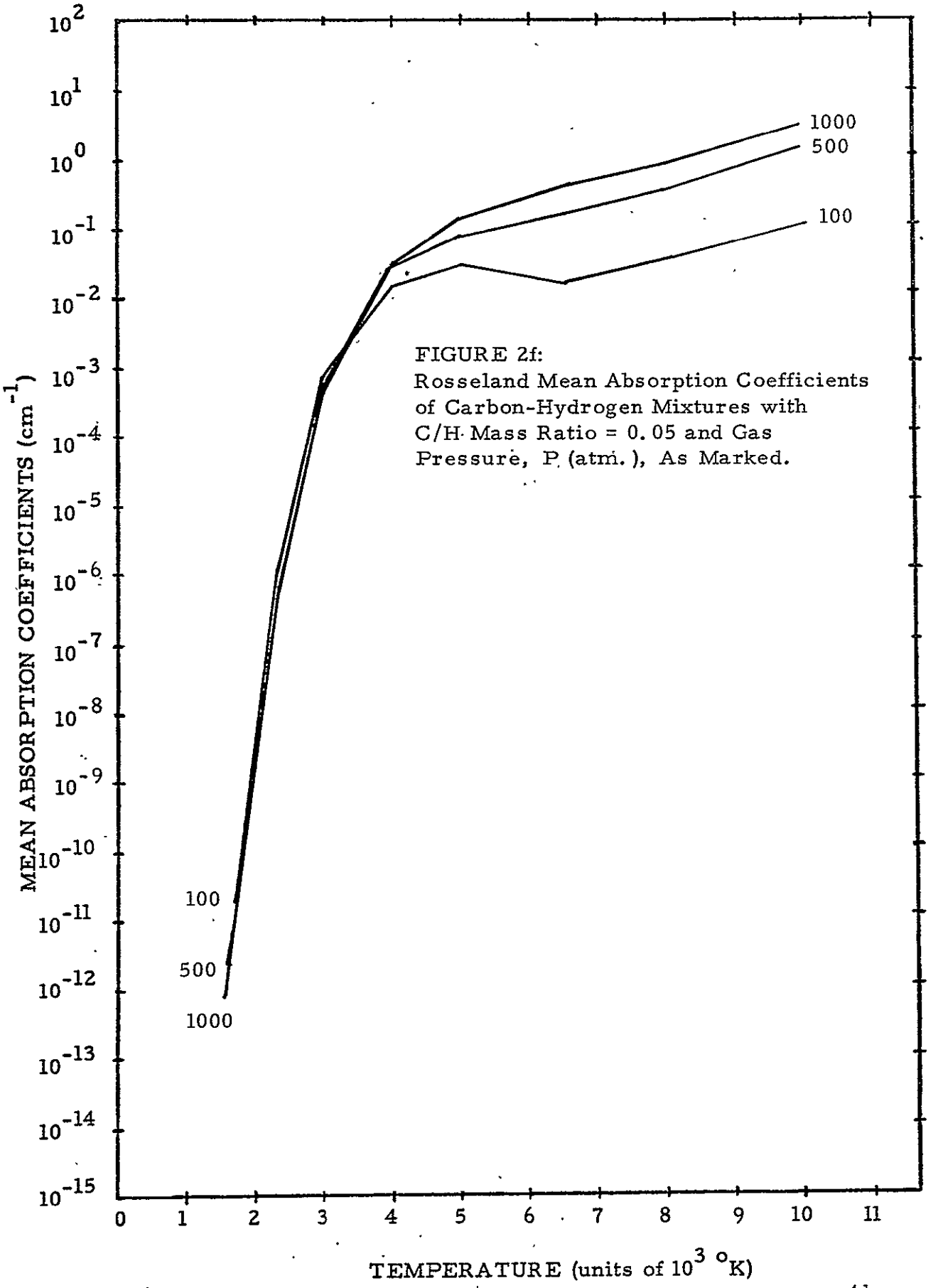

FIGURE 2f:
Rosseland Mean Absorption Coefficients of Carbon-Hydrogen Mixtures with C/H Mass Ratio = 0.05 and Gas Pressure, P (atm.), As Marked.

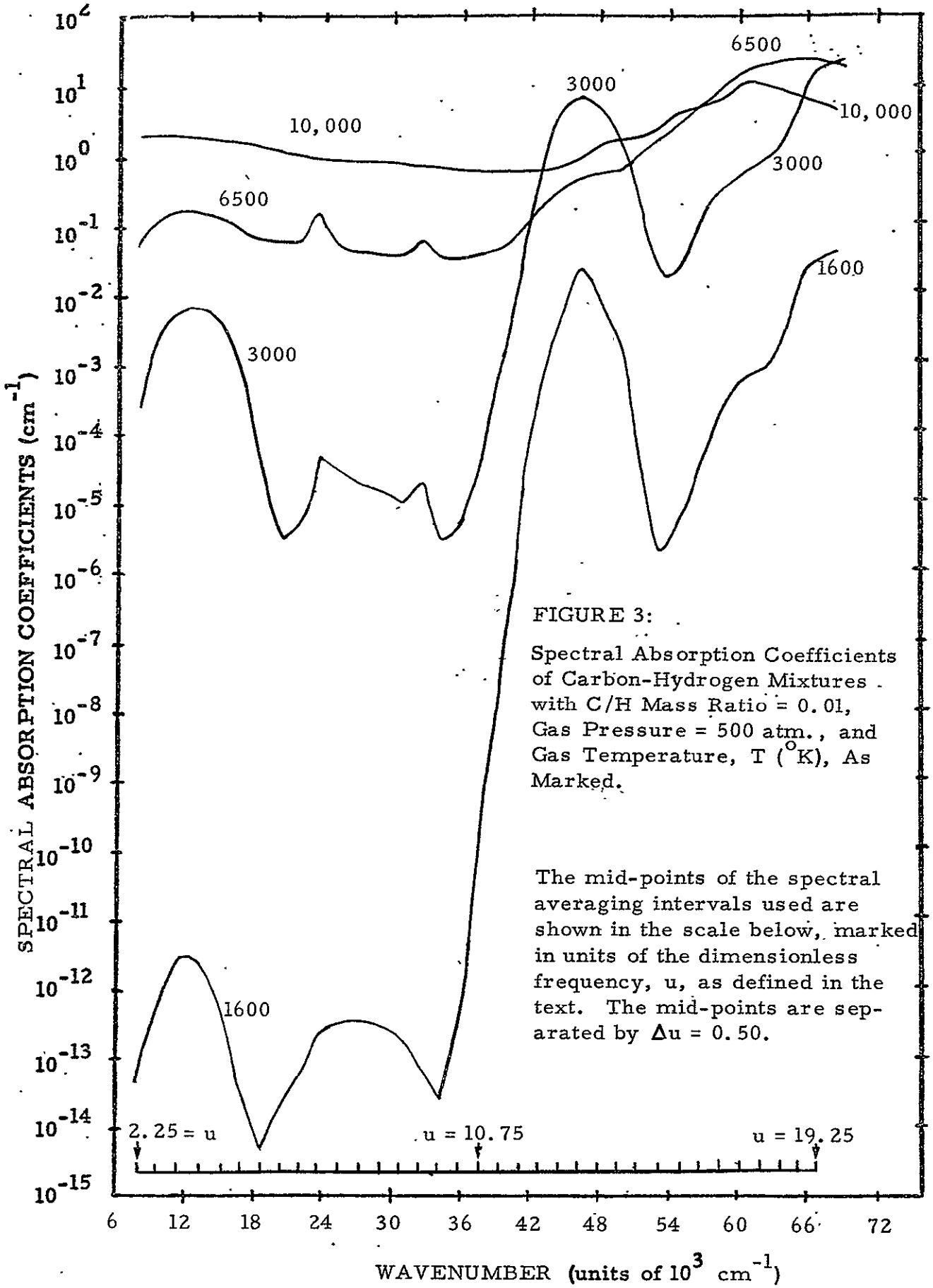

FIGURE 3:

Spectral Absorption Coefficients of Carbon-Hydrogen Mixtures with C/H Mass Ratio = 0.01, Gas Pressure = 500 atm., and Gas Temperature, T (^{o}K), As Marked.

The mid-points of the spectral averaging intervals used are shown in the scale below, marked in units of the dimensionless frequency, u, as defined in the text. The mid-points are separated by $\Delta u = 0.50$.

show the marked variation of these quantities with the gas temperature, and the quite large values ($\sim 5. cm^{-1}$) which they achieve at the highest temperatures and pressures considered. These quantities vary approximately in proportion to the gas pressure and C/H mass ratio, except at the lower temperatures where the higher pressures produce lower optical absorption than do the lower pressures, due to the decline in number density of the strongly-absorbing free radicals relative to the more stable species at the higher pressures.

In Fig. 3 we give a plot of the local Planck mean (spectral) absorption coefficients vs. wavenumber and dimensionless frequency, u, for a gas pressure of 500 atm., C/H mass ratio of 0.01, and gas temperatures of 1600, 3000, 6500, and 10,000°K. Our results are similar for the remaining gas pressures and C/H mass ratios. These results show the very large changes occurring in the local Planck mean absorption coefficient with temperature for wavenumbers less than about 40,000 cm^{-1}, and the less drastic, but quite significant, such changes which take place for wave numbers greater than about 40,000 cm^{-1}. The strong fluctuations which occur in the local Planck mean absorption coefficient with wave-number for the lower temperatures considered are due largely to the contributions of electronic transitions in the molecules C_2H, CH_3, and C_2H_4. At the highest gas temperatures considered, the major absorption mechanisms are the free-free processes for neutral species, H^- photodetachment, and the H_2 Lyman transition. The H_2 Lyman transition is important at the large wavenumber end of the spectral range considered for all of the conditions considered, except for the lowest gas temperatures, an important fact to note.

We must point out that our calculations have been done for fixed values of the gas pressure, so that for each fixed pressure there is a decline as 1/T in total particle number density in the gas mixtures with increasing gas temperature, T. Thus, for T = 10,000° K this particle density is only about 1/6 of that at T = 1600° K for the same gas pressure. We readily see from Figs. 2a - 2f and from Fig. 3, that the cross sections for the important absorbing processes behave so as to more than counterbalance this effect. The large increases in optical absorption with increasing gas temperature are due, in a rough sense, to the increases with temperature of the cross sections for the important absorbing processes, and to the appearance of new important absorption processes with large cross sections, e.g., the H^- photodetachment and free-free processes, at the higher

gas temperatures, where free electron densities become large.

Note that large local Planck mean absorption coefficients at all wave numbers are found only at the highest gas temperatures considered (Fig. 3 , this holds true for the remaining gas pressures and C/H mass ratios considered). This is of importance when the energy source whose radiation is to be absorbed by the gas mixture envisioned has a very broad, and nearly uniform, spectrum. Also note (Fig. 3, and true for the remaining gas pressures and C/H mass ratios considered) that it is nearly true that at each wave number the local Planck mean absorption coefficient increases monotonically with the gas temperature; this is another significant fact. The behavior of the local Planck mean absorption coefficient with gas pressure and C/H mass ratio is approximately what one would expect - it increases approximately in proportion to them, except for the decline in the absorption due to the important free radical species, e.g., C_2H , with increasing gas pressure at the lower gas temperatures considered.

The most significant results of our calculations of the optical constants of the carbon-hydrogen mixtures are their rapid, approximately monotonic, increases with increasing gas temperature to values that are quite large, and their unexpected decrease with increasing gas pressures at the lower gas temperatures. The most important absorption mechanisms are the molecular electronic transitions at the lower gas temperatures, and H^- photodetachment, and the free-free processes for neutral species at the higher gas temperatures. The H_2 Lyman transition is important at the large wave number end of the spectrum except for the lowest gas temperatures considered; the importance of other molecular electronic transitions depends somewhat more strongly on the gas temperature, but CH_3, C_2H, and C_2H_4 have transitions which are important, except at the highest gas temperatures considered. The H_2 Lyman transition is, on the other hand, the only molecular electronic transition that is important at the highest gas temperatures considered; this is largely due to the low C/H mass ratios considered, and to the large oscillator strength of this transition.

Uncertainties in the Calculations of the Optical Constants

Uncertainties in the calculations of the optical constants are partly due to the uncertainties in the composition calculations, which have already been discussed. We have already stated that we believe that all molecules important for the composition calculations have been included in them. It remains to be seen that all molecules important for the calculations of the optical constants have been included in the composition calculations. We believe that this is largely true, however; a survey of Table 1 and Appendix C shows that all possible electrically neutral molecules and molecular fragments containing a sufficiently small total number of nuclei have been included in the composition calculations. Molecules with more than about six nuclei do not have significant mole fractions for the conditions of interest here, and we infer from this, not without some possibility of error, that such molecules are not important for the calculations of the optical constants.

We infer also that for the spectral range considered positive ions are generally not important for the calculations of the optical constants. The molecule CH^+, which was included in these calculations, was found to be of negligible importance in them. H_2^+ was not so considered, and probably is also not important for the optical constants; however, it may possibly be so due to the strength of its spectrally-narrow transitions (Ref. 37 and an unpublished revision of this work). Little is known of the spectrum of C_2^+, but it appears to be of little importance here. The molecule CH_3^+ has been included in our composition calculations, but nothing is known of its optical spectrum. Generally speaking, in view of the low degree of ionization of the mixtures considered (Appendix D), we infer that electronic transitions in molecular positive ions are not of notable importance for the present work; a possible exception here is H_2^+, which we have ignored in our calculations of the optical constants.

Molecular negative ions seem to have, generally speaking, no stable excited states. For this reason, and from the low degree of ionization of the mixtures considered, we infer that non-detaching, non-dissociating, electronic transitions in molecular negative ions are unimportant in the present work. Photodetachment from molecular negative ions (probably resulting in dissociation of the molecule), may be of some importance, however. We have considered photodetachment only from C^- and H^- ions, and we have calculated the mole

fractions for C_2^- only. H_2^- appears to be unstable under all conditions, but it could be involved in important radiative processes as an intermediary. Molecular negative ions have been conjectured to be of importance in radiation transport in the atmospheres of cool stars[44], and such may also be true here. So little is known of the photodetachment cross sections of molecular negative ions that we are unable to infer whether this may be true. Much further experimentation with these species is necessary before these processes can be accurately included in calculations of the present type. We estimate that they can be of somewhat greater importance than photodetachment from atomic negative ions for some conditions, and this means that they could possibly be a major factor in determining the optical constants of the mixtures considered here.

Photoionization processes of molecules have not been considered here, and these are probably not of great importance. We have surveyed the known first ionization potentials of all species listed in Table 1, and find none which would give ground state photoionization for photons with energy in the spectral range we have considered. It is possible that photoionization from vibrationally - and/or electronically excited molecules is of some importance, however. Practically nothing is known of these processes, but it appears possible from study of our results for the photoionization from excited states of the C- and H-atoms that such processes may be of significance in determining the optical constants of the mixtures we have considered. Due to the relatively large cross sections of some photoionization processes (as large as 10^{-16} cm^2 near threshold), this seems possible.

Photodissociation processes of molecules may also be of some significance. Theoretical and experimental photodissociation cross sections for H_2, H_2^+, CH, CH^+, and C_2 have been reported in the literature (Ref. 37 and a yet unpublished revision of it). Photodissociation thresholds fall at about 40,000 cm^{-1} for these molecules (and for most other molecules, as well), and the continuous absorption resulting from them and extending to larger wavenumbers can be important in the sense that the sum total of these processes for all molecules existing in the mixtures we have considered may be of approximately the same strength as, or stronger than, some of the important non-dissociating molecular electronic transitions. Strong photodissociation transitions have not been observed for the molecules that we have included in our composition calculations, but they may nevertheless exist. The very strong photodissociation continuum of

the O_2- molecule shows how significant such processes may be.

A significant omission from the present work is the pressure-induced infrared (vibration-rotation) absorption of H_2. Linsky (J. L. Linsky, "On the Pressure-Induced Opacity of Molecular Hydrogen in Late-Type Stars", to be published) has given algorithms for calculation of the spectral absorption coefficients due to this process, and we find from his work that for temperatures up to about 3000° K that at the small wavenumber end of the spectral range we have considered this process has spectral absorption coefficients much larger than those for the combined processes we have considered. For a gas temperature of 1600° K, we find that the spectral absorption coefficient due to the H_2 pressure-induced transitions is about 10^{-8} P^2 (cm^{-1}) at a wavenumber of 7000 cm^{-1}, with P the gas pressure in atmospheres. This gives absorption coefficients that are several orders of magnitude larger than those we have computed for the same wavenumber region (Appendix D). We may question Linsky's treatment of this problem and his extrapolation of experimental data to more extreme conditions; his alogrithms are surely only approximate, but nevertheless it seems clear that at the lower temperatures considered here, this process is more important than the total of those that we have included. We may reasonably require that at the lower temperatures, where the H_2 pressure-induced absorption is important, that the optical constants we have computed be taken to be not less than those calculated for pure hydrogen with this process taken into account for the same conditions (e.g., the work of Olfe[45] and the work of Patch which is now in progress). The present results should not be applied without taking this into consideration.

We may question our choice of molecular electronic transitions considered in the calculations of the optical constants, the oscillator strengths we have chosen for them (Tables 2 and 3), and the model we have used to represent their spectral absorption coefficients. We have included here all of the known transitions we believed to be of importance, and little better can be done here. We have also included here some transitions in the species C_2H which are only conjectured to exist and have never been observed experimentally, although efforts have been made to do so. The errors made in assuming the spectrum of C_2H as given in Table 3 can be quite significant, since this spectrum makes C_2H a large contributor to the optical constants, particularly at the lower temperatures where the assumed transition at 12,000 cm^{-1} has strong effects. In actuality, the spectrum of C_2H could be quite

different than we have it. We thus can say that this may lead to significant errors in our calculations of the optical constants, but we cannot quantitatively assess these errors.

Some of our oscillator strengths have been estimated (Tables 2 and 3); although those for the diatomic molecules appear reasonably certain for most transitions, the same cannot be said for the triatomic and polyatomic molecules. For example, CH_3 is an important contributor to the optical constants for a fairly wide range within the conditions considered, and oscillator strengths for its transitions had to be estimated by the present author. Here again it is difficult to quantitatively assess the errors arising from our estimations, since the true values may be either larger or smaller than we have estimated. We note, however, that our estimates may be alternately too large and too small, so that errors in them may tend to cancel out. Where one or very few molecules only are strong contributors to the absorption, as here, this effect may not occur, so that errors in the estimated oscillator strengths may have great significance (an order of magnitude and more) for the optical constants.

The models we have used to represent absorption by molecular electronic transitions have been chosen largely because their simplicity makes them suitable for calculations of the present type where many such transitions must be considered. To be sure, these models are inaccurate, and in cases where only one or a few molecules are very strong contributors to the computed optical constants these models must be examined critically. Since there is no real quantitative data on the high temperature absorption of the molecules considered here, it is nearly impossible to say with certainty how good or poor these models are. More accurate line-by-line calculations of molecular absorption, which use assumed line shapes, show that these models may truly represent high temperature molecular absorption to within a factor of 2 or 3 [46]. We are at a loss to say more than this, but we note that in optically thick gases even the line-by-line calculations are subject to errors due to the assumption of line shapes and to simplifications generally necessary in such involved studies.

We note briefly here that we have neglected collective absorption effects and atomic line absorption. Neither of these types of processes should be of importance here. We have noted in our discussion of the errors in the composition calculations that our assumption of the ideal gas equation of state throughout this work can lead to

errors in the calculations of the optical constants of as much as about 20. per cent in the most severe cases. Also, any error in the composition calculations will be carried into the calculations of the optical constants. In optically thin gases the errors in the calculated optical constants will be proportional to the errors in the computed compositions, but in optically thick gases this dependency is reduced to an approximate proportionality to the square root of the errors in the composition calculations. These errors are probably not serious here in view of the possibly still more serious errors in the computed optical constants from other sources. We note finally that we have no comparison with other theoretical or experimental work on the carbon-hydrogen mixtures we have considered. This places us at a disadvantage in assessing the accuracy of our work.

To summarize our semi-quantitative error assessments, we can state as follows: For gas temperatures of less than about 3000° K our results for the optical constants are almost certainly seriously in error (as much as several orders of magnitude) due to our omission of the H_2 pressure-induced infrared absorption. At the highest gas temperatures considered (8000° K and 10,000°K), our results are probably correct to within a factor of 2 or 3, since here the better-known continuous absorption processes provide much of the absorption. For intermediate gas temperatures, our errors probably should be somewhere in between these two limits. Since at these temperatures our most significant errors may be those of omission, our results may be lower limits to the true optical constants. We cannot say this with certainty, however, since estimated molecular absorption could also cause our results to be overly large. It is safe to say that a better error assessment than this should only be based on a detailed comparison of our results with good quantitative experimental data for the same mixtures or for species contained in them at gas temperatures and pressures in the ranges we have considered. The accuracy of the present work must be taken into account in any engineering and design calculations which make use of it; the present results, as presented in Appendix D to this report, must be accepted as true only with the qualifications mentioned in this paragraph.

CONCLUSIONS

In this work we have presented calculations of the species compositions and optical constants of carbon-hydrogen gas mixtures for a wide range of conditions of gas temperature and for three different gas pressures and C/H mass ratios. We have found that for temperatures of about 6500°K and above the spectral absorption coefficients and Planck-and Rosseland mean opacities become quite large, attaining values of several reciprocal centimeters. For temperatures less than about 6500° K, the mentioned optical constants of the gas mixtures considered are small and tend to decrease toward lower gas temperatures, even when the neglected H_2 pressure-induced absorption, which is important for gas temperatures of about 3000° K and less, is given consideration. For the highest gas temperatures our results are surely most accurate, probably sufficiently accurate for most engineering studies, and it seems that this regime will probably be the most interesting for engineering study. It is clear that much further work will be necessary to improve the accuracy of our results at the lower and intermediate temperatures. Much more experimental study in this area is desirable. From this study it is seen that certain mentioned simplifications could be made in further work of this type, but, on the other hand, the many mentioned improvements should be made in any further such work. We have noted the expected accuracy of the results reported here and have given cautions regarding use of these results in engineering radiative heat transfer studies. With these cautions taken into account, the present results should furnish the basis for reasonably informative and reliable radiative heat transfer studies, since the major uncertainties affecting the present work occur only in the low temperature regime.

APPENDIX A

THERMODYNAMIC FUNCTIONS OF THE CH^+ ION

No thermodynamic functions for the CH^+ ion were found after a search of the literature; since it was expected that this species could be important for the calculations of optical constants at the higher temperatures considered here, these were hand-calculated by the present author, as described below.

The basic molecular data were taken from Ref. 41, p. 519, and from Ref. 42. The data actually used in these approximate hand calculations were:

Mass: M = 13.01 a.u.

Ground state: $X^1\Sigma^+$ ($g_0 = 1$; $\epsilon_0 = 0.$)

Symmetry number: $\sigma = 1$

Spectroscopic constants: $\omega_e = 2780\ cm^{-1}$

$\omega_e x_e = 73.\ cm^{-1}$

$B_e = 13.3\ cm^{-1}$

$\alpha_e = 0.49\ cm^{-1}$

Excited States: $A^1\Pi$ ($g_1 = 2$; $\epsilon_1 = 24,000\ cm^{-1}$)

$a^3\Pi$ ($g_2 = 6$; $\epsilon_2 = 8000\ cm^{-1}$)

The expressions used for the approximate thermodynamic functions were (Ref. 43, p. 24)

$$\frac{H_T^o - H_0^o}{T} = 6.95541 + 1.98726 \left\{ \frac{u_e^{-u}}{1-e^{-u}} \right\}$$

$$+ \frac{2.859349}{T} \left\{ \frac{\sum_{i=0}^{2} \epsilon_i g_i e^{-1.43879\epsilon_i/T}}{\sum_{i=0}^{2} g_i e^{-1.43879\epsilon_i/T}} \right\}$$

$$\frac{-(F_T^o - H_0^o)}{T} = 6.863753 \log_{10} M + 11.439588 \log_{10} T - 8.006779 - 4.575835 \log_{10} (B/T) - 4.575835 \log_{10} (1-e^{-u}) + 4.575835 \log_{10}\left[\sum_{i=0}^{2} g_i e^{-1.43879\epsilon_i/T}\right]$$

where, T is the temperature (°K), $u = (1.43879/T)(\omega_e - 2\omega_e x_e)$, $B = B_e - 1/2\,\alpha_e$, and the remaining quantities are given above. In this way, we obtain the following results:

CH^+ Thermodynamic Functions

T(°K)	$\frac{H_T^o - H_0^o}{T}\left(\frac{cal}{°K\text{-}mole}\right)$	$\frac{-(F_T^o - H_0^o)}{T}\left(\frac{cal}{°K\text{-}mole}\right)$
1000	7.126	41.93
2000	7.831	48.00
3000	8.812	51.28
4000	9.592	53.95
5000	10.012	56.14
6000	10.200	57.98
7000	10.288	59.51
8000	10.262	60.94
9000	10.235	62.12
10,000	10.195	63.23

The value for ΔH_f (T = 0° K) of CH^+ was found using the JANAF value of this quantity for CH[43], 141.183 kcal/mole, and an ionization potential for CH of 10.64 ev (245.37 kcal/mole)[42], so that we find ΔH_f(T=0 °K) for CH^+ to be (141.183 + 245.37) kcal/mole = 386.55 kcal/mole (to five figures). These values have been used in the composition calculations of the present work.

APPENDIX B

LISTING OF FIT COEFFICIENTS USED FOR THE THERMODYNAMIC FUNCTIONS OF THE SPECIES INCLUDED IN THE COMPOSITION CALCULATIONS.

On the next pages are given a listing of the fit coefficients used for the thermodynamic functions of the 65 species included in the HUG computer program calculations of the compositions of the carbon-hydrogen mixtures considered. The sources of the necessary data and the temperature ranges for which the fit coefficients were optimized are given in Table 1 of the present report.

The fit coefficients are given for each species in the order (from left to right): E, D, C, B, A, K, and H00, where the fits to the dimensionless enthalpy, $(H_T^o - H_0^o)/RT$, and the dimensionless free energy, $(F_T^o - H_0^o)/RT$, as functions of the temperature, $T(^\circ K)$, are defined by:

$$\frac{H_T^o - H_0^o}{RT} = A + BT + CT^2 + DT^3 + ET^4 \qquad \text{(B-1)}$$

$$\frac{F_T^o - H_0^o}{RT} = A(1 - \ln T) - BT - 1/2CT^2 - 1/3DT^3 - 1/4ET^4 - K \qquad \text{(B-2)}$$

The units in this listing are

A: dimensionless

B: $^\circ K^{-1}$

C: $^\circ K^{-2}$

D: $^\circ K^{-3}$

E: $^\circ K^{-4}$

K: dimensionless

H00 is the value for the heat of formation, ΔH_f, at $0^\circ K$, of the species, in units of cal-mole^{-1}

HIGH TEMPERATURE THERMODYNAMIC FUNCTION FITS IN THE

C	2.6719400E-16	-5.9547000E-12	4.7635099E-08
H	-4.3874300E-16	7.9606300E-12	-5.3260800E-08
H2	-1.3009900E-16	3.3946200E-12	-4.0047799E-08
CH	-4.4294400E-16	1.0319100E-11	-9.7998699E-08
CH2	-2.5443900E-15	5.2843000E-11	-4.4168299E-07
CH3	-4.5483600E-15	9.2362800E-11	-7.4856199E-07
CH4	-6.4944700E-15	1.3342600E-10	-1.0986100E-06
C2	3.6015500E-16	-6.4570900E-12	3.1211300E-08
C2H	4.6303899E-14	-8.3147498E-10	5.4263799E-06
C2H2	-4.0863700E-15	8.3138299E-11	-6.7724699E-07
C2H3	-6.4639900E-15	1.2973400E-10	-1.0379100E-06
C2H4	-6.4266500E-15	1.3849400E-10	-1.1951600E-06
C2H6	-1.4899600E-14	2.9680099E-10	-2.3480300E-06
C3	-1.2278500E-15	2.5802300E-11	-2.1306200E-07
C3H	-4.5250200E-15	9.2928200E-11	-7.5517799E-07
C3H2	-6.5298100E-15	1.3104700E-10	-1.0515500E-06
C3H3	-8.4964299E-15	1.6806600E-10	-1.3184600E-06
C3H4	-1.0929400E-14	2.1671000E-10	-1.7049300E-06
C3H5	-1.3676200E-14	2.6989899E-10	-2.1095300E-06
C3H6	-1.7133300E-14	3.3863500E-10	-2.6512200E-06
C3H8	-2.2493000E-14	4.4520299E-10	-3.4915900E-06
C4	-1.8645800E-15	4.2808300E-11	-3.9270199E-07
C4H	-5.2750500E-15	1.1093400E-10	-9.0964198E-07
C4H2	-8.1617700E-15	1.5976500E-10	-1.2354200E-06
C4H3	-1.0337200E-14	2.0340800E-10	-1.5837900E-06
C4H4	-1.3182300E-14	2.5884899E-10	-2.0093700E-06
C4H5	-1.7548900E-14	3.4107200E-10	-2.6080900E-06
C4H6	-1.9568600E-14	3.8481600E-10	-2.9917700E-06
C4H8	-2.4390600E-14	4.8084899E-10	-3.7509500E-06
C4H10	-2.7262100E-14	5.2038299E-10	-3.8726000E-06
C5	-2.5128200E-15	5.7642400E-11	-5.2815099E-07
C5H	-8.8831298E-15	1.8109500E-10	-1.4333700E-06
C5H2	-1.1289200E-14	2.2057400E-10	-1.7015100E-06
C5H3	-1.2636400E-14	2.4611599E-10	-1.8881000E-06

ORDER E, D, C, B, A, K, HOO

-1.3193800E-04	2.6419000E 00	3.9943700E 00	1.6957600E 05
1.5558000E-04	2.3326600E 00	4.2258500E-01	5.1631000E 04
3.4892299E-04	3.1311400E 00	-2.3341800E 00	0.
5.1871999E-04	3.1449400E 00	3.7079300E 00	1.4118300E 05
1.9121400E-03	2.9051800E 00	4.0528000E 00	9.5180000E 04
3.1030200E-03	2.9940100E 00	4.2074800E 00	3.2805000E 04
4.6558599E-03	2.1511300E 00	7.0935799E 00	-1.5991000E 04
8.3541199E-05	4.1825100E 00	2.9470600E-01	1.9700000E 05
-1.4924500E-02	2.1007200E 01	-8.6712599E 01	1.1330000E 05
2.9216600E-03	3.9140900E 00	4.5479599E-01	5.4325000E 04
4.2485600E-03	3.4814100E 00	5.2015499E 00	6.6900000E 04
5.2708799E-03	3.4558200E 00	3.5412400E 00	1.4580000E 04
9.4449099E-03	1.4308000E 00	1.4508000E 01	-1.6517000E 04
8.5777799E-04	4.9325700E 00	-1.5719400E-01	1.8810400E 05
3.1001500E-03	3.9647100E 00	3.7058900E 00	1.2710000E 05
4.3481099E-03	4.5017700E 00	6.8046899E-01	1.0670000E 05
5.2533899E-03	4.6580000E 00	9.6578900E-01	7.7300000E 04
6.8148000E-03	4.2478099E 00	1.9597700E 00	4.6860000E 04
8.3533499E-03	4.1634900E 00	8.0318899E 00	3.4900000E 04
1.0515300E-02	2.5304300E 00	1.2032600E 01	8.4679999E 03
1.3876000E-02	1.2914300E 00	1.8339700E 01	-1.9482000E 04
1.8183200E-03	6.1271000E 00	-6.3440000E 00	2.4050000E 05
3.7016900E-03	5.8736899E 00	-3.4665900E 00	1.5400000E 05
4.8240699E-03	6.3752000E 00	-8.1913199E 00	1.1130000E 05
6.2411200E-03	5.7493300E 00	-2.9150200E 00	1.0250000E 05
7.8813699E-03	5.3920500E 00	-1.1442000E 00	7.5300000E 04
9.9955598E-03	4.7100300E 00	1.4296400E 00	6.7450000E 04
1.1748200E-02	3.2581700E 00	8.6537499E 00	3.8150000E 04
1.4796400E-02	2.6473400E 00	1.2909800E 01	2.9100000E 03
1.4206700E-02	4.2854600E 00	5.6354899E 00	-2.4480000E 04
2.4409400E-03	7.6483999E 00	-1.4373000E 01	2.4029800E 05
5.5903599E-03	5.4649900E 00	-2.2387700E 00	1.8540000E 05
6.6230399E-03	6.6548400E 00	-7.8060900E 00	1.6500000E 05
7.2744399E-03	7.0991099E 00	-8.2980800E 00	1.3560000E 05

C5H4	-1.3871800E-14	2.7149200E-10	-2.0979100E-06
C5H6	-2.3075200E-14	4.4991900E-10	-3.4565800E-06
C6	-9.2566698E-17	3.6032900E-11	-5.3180000E-07
C6H	-1.0298200E-14	2.0212600E-10	-1.5457700E-06
C6H2	-1.1718400E-14	2.2781800E-10	-1.7440400E-06
C6H3	-1.4397300E-14	2.7972400E-10	-2.1387000E-06
C6H4	-1.7181400E-14	3.3401999E-10	-2.5561000E-06
C6H6	-2.5155000E-14	4.8940899E-10	-3.7484500E-06
C7	5.1094699E-17	4.2223899E-11	-6.3904499E-07
C7H	-1.2953100E-14	2.5215200E-10	-1.9112100E-06
C7H2	-1.4900500E-14	2.9165899E-10	-2.2542100E-06
C8	1.9805500E-16	4.8371699E-11	-7.4608599E-07
C8H	-1.5203400E-14	2.9518600E-10	-2.2327000E-06
C8H2	-1.6575100E-14	3.1942999E-10	-2.4141700E-06
C9	3.2832700E-16	5.4737099E-11	-8.5414299E-07
C9H	-1.7022300E-14	3.2953599E-10	-2.4841700E-06
C9H2	-1.8958600E-14	3.6929400E-10	-2.8340400E-06
C10	4.6776899E-16	6.0982899E-11	-9.6164099E-07
C10H	-1.8614100E-14	3.6002999E-10	-2.7120600E-06
C10H2	-1.9908100E-14	3.8300300E-10	-2.8867700E-06
E-	1.5369100E-18	4.2529600E-14	4.2681800E-10
C+	-1.1395000E-13	2.4758400E-09	-1.9616800E-05
C-	-8.9643598E-16	1.6279200E-11	-9.6509999E-08
H+	-4.4542099E-16	8.0654500E-12	-5.3844800E-08
H-	-4.3874300E-16	7.9606300E-12	-5.3260800E-08
H2+	1.2460200E-15	2.3523900E-11	1.1562400E-07
H3+	-1.8807600E-15	4.0512099E-11	-3.4595900E-07
CH+	-5.4587799E-16	1.9852900E-11	-2.7288000E-07
CH3+	-2.3232200E-15	5.2968400E-11	-4.9299799E-07
C2-	-8.1846899E-16	1.5298400E-11	-1.0873000E-07
C GRAP	-9.4376500E-16	2.1281200E-11	-1.8691600E-07

8.1754599E-03	7.9317999E 00	-1.2705900E 01	1.0490000E 05
1.3342900E-02	3.6012100E 00	4.6684900E 00	2.5200000E 04
2.8958400E-03	9.0772699E 00	-1.9262400E 01	2.8700000E 05
5.8233500E-03	8.3619100E 00	-1.2655000E 01	2.1130000E 05
6.7054999E-03	8.7750900E 00	-1.6932400E 01	1.6860000E 05
8.2009698E-03	8.3128899E 00	-1.2668600E 01	1.5830000E 05
9.8144399E-03	7.9892800E 00	-1.2421000E 01	1.3470000E 05
1.4404800E-02	4.6198699E 00	-1.1678000E 00	2.4000000E 04
3.4815200E-03	1.0578100E 01	-2.7746100E 01	2.8700000E 05
7.1264899E-03	9.0243900E 00	-1.6080400E 01	2.4000000E 05
8.7878499E-03	8.1392200E 00	-1.2896900E 01	2.2000000E 05
4.0667999E-03	1.2079200E 01	-3.2647199E 01	3.3900000E 05
8.3126799E-03	9.7726799E 00	-1.9490100E 01	2.6700000E 05
9.0992799E-03	1.0472400E 01	-2.4942300E 01	2.2500000E 05
4.6540699E-03	1.3579000E 01	-4.1125699E 01	3.3400000E 05
9.2135599E-03	1.1137500E 01	-2.5448300E 01	2.9100000E 05
1.0928800E-02	1.0060800E 01	-2.1292300E 01	2.7100000E 05
5.2402499E-03	1.5079500E 01	-4.6023799E 01	3.9300000E 05
1.0053500E-02	1.2551800E 01	-3.0407300E 01	3.2400000E 05
1.0830600E-02	1.3220700E 01	-3.5754900E 01	2.8200000E 05
-1.8332400E-06	2.5029200E 00	-1.1750000E 01	0.
6.7034899E-02	-8.0679499E 01	4.5431799E 02	4.3016700E 05
2.4590200E-04	2.2657200E 00	5.1597700E 00	1.4080000E 05
1.5692000E-04	2.3315300E 00	7.3370799E-01	3.6523600E 05
1.5558000E-04	2.3326600E 00	-2.7066900E-01	3.4200000E 04
6.0674499E-05	3.6194300E 00	-2.6041300E 00	3.5722000E 05
1.7416500E-03	2.4341100E 00	3.8090800E 00	2.6138600E 05
1.6606500E-03	1.4170900E 00	1.1957400E 01	3.8655000E 05
2.4120600E-03	3.3610800E 00	2.3486900E 00	2.5970000E 05
3.7893400E-04	3.8821500E 00	2.6194700E 00	1.2550000E 05
8.4298999E-04	1.1157900E 00	-6.0329000E 00	0.

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APPENDIX

EQUILIBRIUM COMPOSITIONS OF THE

The following pages give the equilibrium compositions, carbon/hydrogen mass ratios of 0.005, 0.01, and 0.05, gas of 1600, 2200, 3000, 4000, 5000, 6500, 8000, and 10,000° K. atures are as printed. In none of these cases was condensed indicates this fact for each set of conditions considered).

Note that the results are spread across facing pages. in the calculations, and a vertical listing of these would have to below each printed value of "TEMPERATURE" (° K) and "PRES- considered; these are arranged in seven vertical columns accord-

C	H	H_2	CH
C_2	C_2H	C_2H_2	C_2H_3
C_3H	C_3H_2	C_3H_3	C_3H_4
C_4	C_4H	C_4H_2	C_4H_3
C_4H_8	C_4H_{10}	C_5	C_5H
C_5H_6	C_6	C_6H	C_6H_2
C_7	C_7H	C_7H_2	C_8
C_9H	C_9H_2	C_{10}	$C_{10}H$
C^-	H^+	H^-	H_2^+
C_2^-			

Thus, the species whose mole fraction is printed in the fourth of 5000° K and less for each pressure and C/H mass ratio 10^{-6}. It was not possible with the computer program used to and the ionized species for these cases; thus, for temperatures species are printed. Mole fractions for only 54 species are point rotation; the often repeated value $1.8048514 \times 10^{-35}$

in terms of mole fractions, for carbon-hydrogen mixtures with pressures of 100, 500, and 1000 atmospheres, and gas temperatures The carbon-hydrogen mass ratios, gas pressures, and gas temper- carbon (graphite) calculated to be present ("MOLES OF SOLID = 0." The arrangement of the 72 cases will be obvious upon inspection.

This is owing to the fact that 64 gas-phase species were included have been continued over three pages. The mole fractions printed SURE" (atm.) are the mole fractions of the 64 gas-phase species ing to the following plan:

CH_2	CH_3	CH_4
C_2H_4	C_2H_6	C_3
C_3H_5	C_3H_6	C_3H_8
C_4H_4	C_4H_5	C_4H_6
C_5H_2	C_5H_3	C_5H_4
C_6H_3	C_6H_4	C_6H_6
C_8H	C_8H_2	C_9
$C_{10}H_2$	e^-	C^+
H_3^+	CH^+	CH_3^+

column, sixth row, in all cases is C_6H_2, etc. For temperatures considered, the mole fraction of free electrons, e^-, was less than perform the iterations necessary to find the mole fractions for e^- of 5000° K and less, no mole fractions for e^- and the ionized shown in these cases. All mole fractions are in floating · is actually the machine zero, and not a true value.

C/H Mass Ratio = 0.005

TEMPERATURE =10000.0000 PRESSURE = 100.00000 MOLES OF GAS =

4.1754513E-04	9.3253666E-01	9.9010590E-03	3.8292468E-06
6.2742076E-09	4.7966571E-08	9.1432127E-13	5.2998590E-16
6.9950837E-16	4.3838260E-18	5.6138095E-21	3.9568771E-24
3.2156304E-20	1.9124003E-20	1.2897257E-23	2.1500286E-26
1.8048514E-35	1.8048514E-35	8.6661153E-26	1.0536135E-27
1.8048514E-35	3.6872523E-31	4.2070967E-31	1.9964143E-34
1.8048514E-35	1.8048514E-35	1.8048514E-35	1.8048514E-35
1.8048514E-35	1.8048514E-35	1.8048514E-35	1.8048514E-35
4.0454981E-08	3.5037760E-03	6.2902754E-05	6.4891672E-05
1.3773892E-11			

TEMPERATURE = 8000.0000 PRESSURE = 100.00000 MOLES OF GAS =

4.1992710E-04	9.6371841E-01	3.5086830E-02	1.1761837E-05
4.0867952E-08	3.2672870E-08	1.4916021E-10	2.0366808E-13
2.4676229E-13	3.7451628E-15	1.8691636E-17	4.1068160E-20
1.0826037E-17	3.8389561E-17	1.1750739E-19	5.0606529E-22
1.1957821E-34	1.8048514E-35	2.4984932E-22	1.5728709E-23
1.8048514E-35	2.7218852E-27	4.6424122E-26	8.2222545E-29
3.1568244E-32	1.3956286E-31	9.8813088E-35	1.8048514E-35
1.8048514E-35	1.8048514E-35	1.8048514E-35	1.8048514E-35
1.0948537E-08	3.6369308E-04	1.4057832E-05	1.4231009E-05
4.9093888E-11			

TEMPERATURE = 6500.0000 PRESSURE = 100.00000 MOLES OF GAS =

4.3258638E-04	8.6109382E-01	1.3836936E-01	3.9821722E-05
3.6745239E-07	1.2512658E-06	3.8504841E-08	1.0353886E-10
1.5403400E-10	5.3590252E-12	9.7931343E-14	6.4395133E-16
8.3018031E-15	1.8472333E-13	2.1394404E-15	2.2124662E-17
6.0433578E-28	1.8048514E-35	2.2650327E-18	5.9840760E-19
1.7657625E-28	1.4022028E-22	1.4307428E-20	9.3575311E-23
1.8777149E-26	3.4563020E-25	5.8006607E-28	1.6166379E-30
2.5821616E-33	1.8048514E-35	1.8048514E-35	1.8048514E-35
2.2230037E-09	2.6190454E-05	2.1168267E-06	2.3371201E-06
1.8033646E-10			

C/H Mass Ratio = 0.005

0.99358 MOLES OF SOLID = 0.

5.8965731E-09	9.8964102E-11	5.1104313E-14
6.5112609E-19	4.9595934E-25	5.7068874E-14
1.7108158E-24	9.4048563E-30	1.8048514E-35
4.6281511E-29	1.9501582E-32	1.8048514E-35
3.0394302E-29	8.5561820E-32	5.9125125E-34
1.8048514E-35	1.8048514E-35	1.8048514E-35
1.8048514E-35	1.8048514E-35	1.8048514E-35
1.8048514E-35	3.5074784E-03	4.3025497E-07
1.1020214E-06	2.2199992E-07	1.1851175E-11

0.96642 MOLES OF SOLID = 0.

7.1043596E-08	5.8279760E-09	1.1499094E-11
7.6704803E-16	5.8420969E-21	5.1942989E-12
4.4899856E-20	8.1588532E-25	2.9996811E-30
3.3834975E-24	3.9545151E-27	3.3416248E-30
1.2738000E-24	1.3298901E-26	2.5512589E-28
5.4427524E-31	7.5997919E-34	1.8048514E-35
1.8048514E-35	1.8048514E-35	1.8048514E-35
1.8048514E-35	3.6738842E-04	1.9748552E-06
1.4128566E-06	1.4651621E-07	1.8415705E-10

0.87843 MOLES OF SOLID = 0.

9.4291247E-07	3.9104940E-07	3.0909861E-09
1.5475858E-12	7.2813078E-17	8.2907653E-10
1.5880416E-15	8.5062060E-20	1.7619174E-24
4.2082860E-19	1.0558971E-21	2.7557804E-24
1.1159960E-19	4.2567366E-21	2.3582548E-22
1.5032733E-24	5.6651729E-27	3.0073201E-32
1.4095343E-29	1.7189984E-31	3.1892936E-34
1.8048514E-35	2.8605915E-05	3.5978537E-07
1.7610988E-06	9.2902970E-08	3.5497828E-09

C/F Mass Ratio = 0.005

TEMPERATURE = 5000.0000 PRESSURE = 100.00000 MOLES OF GAS =

2.1247186E-04	4.6580326E-01	5.3370185E-01	8.2744918E-05
2.6571983E-06	1.1849738E-04	2.6068239E-05	1.2124105E-07
2.8729633E-07	2.5533660E-08	2.1995096E-09	5.4452154E-11
1.5438181E-11	4.3590888E-09	2.5731977E-10	6.8285064E-12
4.2400867E-20	3.3028248E-26	1.0354186E-13	1.7607405E-13
5.3749726E-20	5.6672714E-17	5.3051792E-14	1.7907303E-15
1.8923215E-19	1.6343945E-17	7.4406472E-20	1.2141507E-22
2.2601320E-23	7.8424918E-26	2.1282522E-28	7.9955164E-26

TEMPERATURE = 4000.0000 PRESSURE = 100.00000 MOLES OF GAS =

1.1213864E-05	1.4603523E-01	8.5347451E-01	1.2335539E-05
2.9006251E-07	1.3101868E-04	1.5258000E-04	7.4236103E-07
8.9985737E-07	1.4369203E-07	3.8176749E-08	2.4867404E-09
8.7645607E-12	2.4735767E-08	5.2328712E-09	2.3402166E-10
4.9821361E-17	3.9319506E-22	2.1810324E-13	1.7772702E-12
9.1365694E-17	1.4352151E-16	9.5457855E-13	1.1796592E-13
1.7998977E-18	5.3561862E-16	4.6997422E-18	1.1722773E-21
2.8267837E-21	1.9164825E-23	7.4495705E-27	1.5950892E-23

TEMPERATURE = 3000.0000 PRESSURE = 100.00000 MOLES OF GAS =

2.7172049E-08	1.5540674E-02	9.8381680E-01	1.1871968E-07
7.5549691E-10	1.2535980E-05	1.7349942E-04	6.2901399E-07
1.5362853E-07	5.2026556E-08	6.1344622E-08	1.5201147E-08
3.7551322E-14	3.7980441E-09	5.0193265E-09	3.8989896E-10
7.5545428E-15	8.1783965E-19	2.7764973E-15	2.3701964E-13
1.4880708E-14	7.9697258E-19	1.1120170E-13	8.9403026E-14
2.9923519E-20	5.6587353E-17	1.1902879E-18	6.5921950E-24
3.1021328E-22	5.1523314E-24	3.9009455E-29	1.2734429E-24

C/H Mass Ratio = 0.005

0.65178 MOLES OF SOLID

1.1101552E-05	3.8994217E-05	1.8668435E-06
1.1380658E-08	3.8729571E-12	2.4762453E-07
3.1925499E-10	6.1897820E-14	8.5859556E-18
4.4712088E-13	2.3986626E-15	2.5038008E-17
8.0327497E-14	1.4519129E-14	2.9097123E-15
7.4370902E-17	8.8761517E-19	2.3205225E-22
8.8888407E-21	5.4030280E-22	6.7084164E-25
4.2637382E-27		

0.53915 MOLES OF SOLID 0.

6.6463776E-06	1.4377854E-04	3.0229479E-05
3.1950013E-07	3.6272619E-10	1.5908128E-07
2.3344363E-08	1.1395125E-11	4.8547124E-15
3.6614215E-11	2.8087833E-13	8.2033980E-15
1.3884255E-12	7.7742506E-13	3.9277991E-13
8.3355354E-15	2.1715012E-16	1.5120544E-18
5.5644631E-19	1.1937693E-19	2.7587664E-23
3.0161012E-24		

0.50352 MOLES OF SOLID = 0.

4.8167658E-07	1.5777311E-04	2.9451265E-04
2.6037492E-06	1.2648031E-08	2.3392701E-09
2.3797827E-07	4.0935694E-10	6.5093591E-13
1.9798437E-10	2.1075004E-12	2.5703787E-13
3.6593939E-13	9.1330945E-13	1.6367407E-12
1.1189247E-14	8.1341923E-16	7.7169473E-16
5.7655251E-20	7.5836645E-20	5.7280291E-25
1.4866717E-24		

C/H Mass Ratio = 0.005

TEMPERATURE = 2200.0000 PRESSURE = 100.00000 MOLES OF GAS =

5.8539442E-13	5.5948948E-04	9.9860528E-01	1.6744671E-11
2.4217167E-15	6.6328984E-09	3.5553276E-06	7.3286019E-09
2.8648490E-11	2.9620536E-11	2.5846174E-10	4.3154836E-10
4.7390310E-21	8.6903554E-14	1.5513783E-12	2.4623013E-13
2.8324714E-15	5.6386554E-18	2.4317638E-22	6.2643151E-19
9.4877039E-16	2.8940640E-27	3.4475393E-20	3.9731203E-19
7.5459135E-29	2.1682849E-24	1.6580885E-25	4.8406229E-34
2.5472108E-31	1.5834033E-32	1.8048514E-35	9.3859802E-35

TEMPERATURE = 1600.0000 PRESSURE = 100.00000 MOLES OF GAS =

3.8624014E-20	5.4279092E-06	9.9915469E-01	1.4910190E-17
2.5520781E-24	6.7166253E-15	9.2745634E-10	8.3078189E-13
2.3507038E-18	1.3003906E-17	1.7655115E-15	4.5355018E-14
3.1312020E-33	9.4798828E-23	6.7798246E-20	2.9221686E-20
3.4674222E-18	2.0978685E-19	2.4028257E-35	8.2112799E-30
2.1930325E-20	1.8048514E-35	5.6609593E-33	2.8066831E-30
1.8048514E-35	1.8048514E-35	1.8048514E-35	1.8048514E-35
1.8048514E-35	1.8048514E-35	1.8048514E-35	1.8048514E-35

C/H Mass Ratio = 0.005

```
0.49952     MOLES OF SOLID =  0.
     1.2080223E-09     1.9070822E-05     8.1185358E-04
     7.8974932E-07     2.9538013E-08     1.1501892E-14
     1.3814128E-08     1.4235627E-10     1.4300328E-12
     6.7146531E-13     1.1302760E-14     1.0425955E-14
     2.6970416E-18     4.9830864E-17     5.4490418E-16
     1.0537585E-19     3.3006921E-20     3.6876266E-17
     3.0525327E-28     5.2977070E-27     3.9623077E-35
     1.4587294E-33
```

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0.49937     MOLES OF SOLID =  0.
     6.3497786E-14     2.3647507E-07     8.3972410E-04
     9.1459914E-09     6.7365274E-09     4.8798556E-24
     4.2341923E-12     5.6227696E-13     8.3345817E-14
     8.9872452E-19     3.1313958E-20     5.0358233E-19
     1.6907888E-28     4.8194445E-26     7.0994777E-24
     2.1601133E-30     5.5940126E-30     1.4266429E-22
     1.8048514E-35     1.8048514E-35     1.8048514E-35
     1.8048514E-35
```

C/H Mass Ratio = 0.005

TEMPERATURE =10000.0000 PRESSURE = 500.00000 MOLES OF GAS =

4.1655154E-04	9.4992349E-01	4.6273397E-02	1.8466668E-05
3.1221918E-08	1.1538493E-06	1.0632099E-10	2.9791632E-13
8.3934103E-14	2.5427803E-15	1.5740664E-17	5.3632444E-20
3.9814139E-18	1.1446161E-17	3.7315415E-20	3.0070802E-22
1.0260781E-33	1.8048514E-35	5.3521819E-23	3.1455571E-24
1.8048514E-35	1.1359119E-27	6.2651858E-27	1.4371828E-29
9.3229446E-33	1.2821531E-32	1.8048514E-35	1.8048514E-35
1.8048514E-35	1.8048514E-35	1.8048514E-35	1.8048514E-35
8.9117894E-08	1.5340821E-03	1.3428796E-04	1.3734443E-04
1.5135086E-10			

TEMPERATURE = 8000.0000 PRESSURE = 500.00000 MOLES OF GAS =

4.2040220E-04	8.5958077E-01	1.3956844E-01	5.2513723E-05
2.0480236E-07	7.3020666E-07	1.4866821E-08	9.0530374E-11
2.7605669E-11	1.8685157E-12	4.1589107E-14	4.0751563E-16
1.3593885E-15	2.1497787E-14	2.9346218E-16	5.6363758E-18
2.3495119E-27	5.0445690E-35	1.5704108E-19	4.4089442E-20
7.1358292E-29	8.5637885E-24	6.5139745E-22	5.1451698E-24
4.9717304E-28	9.8024135E-27	3.0951713E-29	3.9481461E-32
2.6560887E-35	1.8048514E-35	1.8048514E-35	1.8048514E-35
2.3890843E-08	1.4882893E-04	2.7329971E-05	2.5971348E-05
5.3624558E-10			

TEMPERATURE = 6500.0000 PRESSURE = 500.00000 MOLES OF GAS =

3.7752106E-04	6.2957707E-01	3.6983400E-01	1.2704477E-04
1.3992900E-06	1.7419064E-05	1.9595615E-06	1.9262613E-08
9.3568571E-09	1.1900564E-09	7.9500876E-11	1.9110475E-12
6.0194354E-13	4.8963599E-11	2.0731009E-12	7.8372760E-14
1.3976835E-21	4.4729830E-28	7.1663165E-16	6.9212871E-16
1.3334119E-22	1.9358457E-19	7.2208729E-17	1.7264654E-18
1.1311696E-22	7.6116399E-21	4.6699502E-23	4.2495093E-26
1.0827464E-27	4.9981122E-30	7.9947292E-33	1.4819082E-30
4.7376601E-09	7.8412629E-06	3.7795426E-06	2.5579519E-06
1.6770485E-09			

C/H Mass Ratio = 0.005

0.95702 MOLES OF SOLID = 0.

1.3746264E-07	1.1152500E-08	2.7839535E-11
1.7693141E-15	3.1492360E-20	1.4165610E-12
1.1209544E-19	2.9788354E-24	3.7888562E-29
3.1290893E-24	6.3736723E-27	8.5850599E-30
4.3864953E-25	5.9691982E-27	1.9939639E-28
1.6802752E-31	3.8397870E-34	1.8048514E-35
1.8048514E-35	1.8048514E-35	1.8048514E-35
1.8048514E-35	1.5490043E-03	1.9438541E-07
1.1275133E-05	4.8484212E-07	6.0482319E-10

0.87757 MOLES OF SOLID = 0.

1.4145846E-06	5.1752149E-07	4.5538707E-09
1.5205488E-12	2.3033495E-16	1.3029870E-10
1.9869687E-15	1.6102044E-19	1.1774441E-23
1.6806068E-19	8.7599158E-22	3.3011890E-24
1.5923892E-20	7.4143002E-22	6.3433051E-23
1.5189162E-25	9.4585332E-28	4.9580836E-33
2.4315903E-31	3.6627539E-33	1.8048514E-35
1.8048514E-35	1.6015470E-04	9.0707269E-07
1.1499080E-05	3.0012278E-07	7.5026487E-09

0.72988 MOLES OF SOLID = 0.

1.0997060E-05	1.6672678E-05	4.8176909E-07
1.0525312E-09	6.6179985E-13	1.3776524E-08
1.7228547E-11	3.3735811E-15	9.3385123E-19
5.4495695E-15	4.9985814E-17	4.7691200E-19
4.7186835E-16	6.5796601E-17	1.3325565E-17
1.0139179E-19	1.3968401E-21	9.9094621E-26
1.3545049E-24	6.0387724E-26	3.6582162E-29
5.7679152E-32	1.3971445E-05	1.2857495E-07
7.0463370E-06	1.2136985E-07	6.1975475E-08

C/H Mass Ratio = 0.005

TEMPERATURE = 5000.0000 PRESSURE = 500.00000 MOLES OF GAS =

5.7710357E-05	2.4729843E-01	7.5215341E-01	5.9659890E-05
9.8016357E-07	1.1603051E-04	6.7758519E-05	8.3654808E-07
3.8204612E-07	9.0133804E-08	2.0610535E-08	1.3544629E-09
1.0503047E-11	7.8723385E-09	1.2335872E-09	8.6898320E-11
7.1122057E-17	3.9038493E-22	9.5665960E-14	4.3184288E-13
1.7376043E-17	7.1111173E-17	1.7670655E-13	1.5833295E-14
3.2246408E-19	7.3931932E-17	8.9345905E-19	2.8098361E-22
1.8856145E-22	1.7368493E-24	9.0839721E-28	9.0591609E-25

TEMPERATURE = 4000.0000 PRESSURE = 500.00000 MOLES OF GAS =

1.9016812E-06	6.8215817E-02	9.3114117E-01	4.8858264E-06
4.1708691E-08	4.4001316E-05	1.1968160E-04	1.3600116E-06
2.5624682E-07	9.5568545E-08	5.9303255E-08	9.0220919E-09
9.0608710E-13	5.9725897E-09	2.9510376E-09	3.0823933E-10
4.5607324E-15	1.9634619E-19	1.9118527E-14	3.6386741E-13
1.3000504E-15	1.0667474E-17	1.6571193E-13	4.7829514E-14
1.1343447E-19	7.8840647E-17	1.6157198E-18	6.2644069E-23
2.9915199E-22	4.7369813E-24	2.8621057E-28	1.4313212E-24

TEMPERATURE = 3000.0000 PRESSURE = 500.00000 MOLES OF GAS =

2.2523079E-09	6.9796122E-03	9.9221793E-01	2.2098331E-08
2.5954559E-11	9.6709788E-07	3.0056723E-05	2.4470088E-07
4.9120188E-09	3.7354648E-09	9.8907120E-09	5.5037478E-09
2.2159357E-16	5.0329534E-11	1.4936188E-10	2.6054216E-11
2.8826442E-14	1.5736709E-17	6.7905505E-18	1.3017389E-15
4.6668038E-15	8.0784212E-22	2.5311970E-16	4.5698143E-16
1.2571044E-23	5.3383854E-20	2.5215845E-21	1.1477918E-27
5.0269285E-26	1.8748921E-27	1.1666897E-33	8.5525730E-29

C/H Mass Ratio = 0.005

```
0.57032     MOLES OF SOLID =  0.
     2.1247785E-05    1.9811582E-04    2.5177666E-05
     2.0844772E-07    4.9986231E-10    1.2404823E-07
     2.1080393E-08    1.0849388E-11    1.0604638E-14
     1.5104250E-11    2.1509595E-13    5.9600793E-15
     5.2297773E-13    2.5092770E-13    1.3348936E-13
     1.7455543E-15    5.5302374E-17    1.0187851E-19
     5.4606211E-20    8.8109574E-21    2.1083860E-24
     1.2823931E-25
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```
0.51729     MOLES OF SOLID =  0.
     6.1484035E-06    3.1064824E-04    1.5254672E-04
     1.3670850E-06    8.4663929E-09    1.9395741E-08
     1.9781377E-07    2.2552304E-10    5.2411925E-13
     1.1263647E-10    2.0181129E-12    1.3766337E-13
     6.6391091E-13    8.6824651E-13    1.0245456E-12
     7.8935146E-15    4.8027999E-16    1.8243015E-17
     6.9449669E-20    3.4798845E-20    1.2500205E-24
     6.3211390E-25
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```
0.50119     MOLES OF SOLID =  0.
     2.0133709E-07    1.4809237E-04    6.2077617E-04
     2.2746032E-06    5.5717559E-08    3.3307107E-11
     1.9348654E-07    7.4738991E-10    5.9930211E-12
     2.9708993E-11    7.1016047E-13    1.9449899E-13
     4.5131558E-15    2.5294175E-14    1.0179195E-13
     1.2843346E-16    2.0966386E-17    1.0030387E-16
     2.2542565E-23    6.6584781E-23    4.1334710E-29
     2.2421519E-28
```

C/H Mass Ratio = 0.005

TEMPERATURE = 2200.0000 PRESSURE = 500.00000 MOLES OF GAS =

2.3938060E-14	2.5024954E-04	9.9891031E-01	1.5313277E-12
2.0247605E-17	1.2402389E-10	1.4867328E-07	6.8537113E-10
1.0952530E-13	2.5325434E-13	4.9421048E-12	1.8454242E-11
1.6563809E-24	6.7929797E-17	2.7120104E-15	9.6264675E-16
6.1950848E-16	6.1682225E-18	1.7378135E-26	1.0011673E-22
8.4830132E-18	4.2286469E-32	1.1265554E-24	2.9035355E-23
2.2543126E-34	1.4486730E-29	2.4774987E-30	1.8048514E-35
1.8048514E-35	1.8048514E-35	1.8048514E-35	1.8048514E-35

TEMPERATURE = 1600.0000 PRESSURE = 500.00000 MOLES OF GAS =

1.5452257E-21	2.4274381E-06	9.9915755E-01	1.3338381E-18
2.0423594E-26	1.2019178E-16	3.7111043E-11	7.4333081E-14
8.4144810E-21	1.0408493E-19	3.1598816E-17	1.8151456E-15
1.8048514E-35	6.7879038E-26	1.0855149E-22	1.0461878E-22
6.9396672E-19	2.0993345E-19	1.8048514E-35	1.1761127E-33
1.7559458E-22	1.8048514E-35	1.8048514E-35	1.7981314E-34
1.8048514E-35	1.8048514E-35	1.8048514E-35	1.8048514E-35
1.8048514E-35	1.8048514E-35	1.8048514E-35	1.8048514E-35

C/H Mass Ratio = 0.005

```
0.49944     MOLES OF SOLID =  0.
     2.4706884E-10     8.7229563E-06     8.3046901E-04
     1.6517540E-07     3.0898662E-08     1.9662147E-17
     1.3211167E-09     3.0447098E-11     1.5297400E-12
     5.8708392E-15     2.2101034E-16     4.5592690E-16
     9.6398969E-22     3.9832100E-20     9.7410688E-19
     1.7222151E-23     1.2064324E-23     6.7413596E-20
     4.1698941E-34     1.6184688E-32     1.8048514E-35
     1.8048514E-35
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```
0.49937     MOLES OF SOLID =  0.
     1.2701770E-14     1.0577344E-07     8.3987259E-04
     1.8298342E-09     6.7388920E-09     7.8117973E-27
     3.7891472E-13     1.1251412E-13     8.3389585E-14
     7.1947548E-21     5.6054904E-22     2.0157224E-20
     5.4151900E-32     3.4514909E-29     1.1368982E-26
     3.0944965E-34     1.7919285E-33     2.2849980E-25
     1.8048514E-35     1.8048514E-35     1.8048514E-35
     1.8048514E-35
```

C/H Mass Ratio = 0.005

TEMPERATURE =10000.0000 PRESSURE =1000.00000 MOLES OF GAS =

4.0982804E-04	9.1176317E-01	8.5260570E-02	3.4877462E-05
6.0444309E-08	4.2881337E-06	7.5851063E-10	4.0800012E-12
6.1379123E-13	3.5695576E-14	4.2418163E-16	2.7744721E-18
2.9844136E-17	1.6470428E-16	1.0307579E-18	1.5945449E-20
1.4183699E-30	1.8048514E-35	7.8943333E-22	8.9064642E-23
1.0168399E-32	3.2967968E-26	3.4906365E-25	1.5371137E-27
5.3243177E-31	1.4056380E-30	3.7592738E-33	2.2642075E-35
1.8048514E-35	1.8048514E-35	1.8048514E-35	1.8048514E-35
1.2259963E-07	1.0530541E-03	1.8022783E-04	1.8098247E-04
4.0970581E-10			

TEMPERATURE = 8000.0000 PRESSURE =1000.00000 MOLES OF GAS =

4.0814836E-04	7.7328760E-01	2.2590504E-01	9.1729754E-05
3.8607449E-07	2.4766596E-06	9.0724156E-08	9.9399346E-10
1.8180334E-10	2.2140360E-11	8.8664914E-13	1.5631503E-14
9.6615322E-15	2.7490360E-13	6.7518546E-15	2.3332171E-16
1.8338111E-24	1.2745866E-31	2.1671979E-18	1.0947234E-18
3.3406852E-26	2.2947445E-22	3.1405010E-20	4.4631025E-22
2.5867775E-26	9.1763295E-25	5.2132041E-27	3.9886674E-30
9.3744142E-33	3.9775692E-35	1.8048514E-35	1.8048514E-35
3.2916763E-08	9.4342884E-05	3.4892021E-05	2.9621060E-05
1.4346054E-09			

TEMPERATURE = 6500.0000 PRESSURE =1000.00000 MOLES OF GAS =

2.9544734E-04	5.1137984E-01	4.8800721E-01	1.6151781E-04
1.7140183E-06	3.4662293E-05	6.3345550E-06	1.0115728E-07
2.9142812E-08	6.0213466E-09	6.5346575E-10	2.5518029E-11
1.8063482E-12	2.3869525E-10	1.6417817E-11	1.0082888E-12
2.0344732E-19	1.7182629E-25	3.3659743E-15	5.2811232E-15
1.1511377E-20	1.4231623E-18	8.6237868E-16	3.3495835E-17
1.3016083E-21	1.4228379E-19	1.4181235E-21	7.6536826E-25
4.9584062E-26	3.7183098E-28	3.5274686E-31	1.0621986E-28
5.8807686E-09	4.0155912E-06	4.8692847E-06	2.1280439E-06
3.2582530E-09			

C/H Mass Ratio = 0.005

0.92212 MOLES OF SOLID = 0.

4.9838443E-07	7.7620320E-08	3.7195346E-10
4.6515155E-14	3.0509955E-18	5.3962748E-12
1.1131750E-17	5.6786589E-22	2.6616693E-26
3.1851732E-22	1.2454547E-24	3.2203650E-27
2.3842368E-23	6.2283161E-25	3.9938864E-26
3.4498323E-29	1.5133809E-31	1.8048514E-35
1.8048514E-35	1.8048514E-35	1.8048514E-35
1.8048514E-35	1.0829639E-03	1.3677452E-07
2.8521382E-05	6.5488544E-07	3.0105111E-09

0.81567 MOLES OF SOLID = 0.

4.4458081E-06	2.9264055E-06	4.6330947E-08
3.0038202E-11	1.4729977E-14	4.7693510E-10
1.3712981E-13	1.9994287E-17	4.7329765E-21
1.2517160E-17	1.1738805E-19	7.9593685E-22
7.1138266E-19	5.9594815E-20	9.1735612E-21
2.3705810E-23	2.6560085E-25	4.5070029E-30
4.4198656E-29	1.1978733E-30	6.1565419E-34
1.8048514E-35	1.1364291E-04	6.2052968E-07
2.3596824E-05	3.6940587E-07	2.9894286E-08

0.67182 MOLES OF SOLID = 0.

2.2712500E-05	5.5939471E-05	2.6258908E-06
8.9792829E-09	1.4899877E-11	2.6412925E-08
3.7372222E-10	1.1888195E-13	8.6846378E-17
1.1389551E-13	1.6971336E-15	2.6304625E-17
5.8490443E-15	1.3249282E-15	4.3591232E-16
3.1956599E-18	7.1520189E-20	1.3390035E-23
3.9630254E-23	2.8702488E-24	1.0312399E-27
6.7162603E-30	1.1080073E-05	6.3440129E-08
9.5230547E-06	9.7284393E-08	1.3109968E-07

C/H Mass Ratio = 0.005

TEMPERATURE = 5000.0000 PRESSURE =1000.00000 MOLES OF GAS =

2.7966925E-05	1.8226278E-01	8.1712720E-01	4.2616720E-05
4.6037365E-07	8.0332403E-05	6.9149500E-05	1.2584114E-06
2.5636304E-07	8.9152555E-08	3.0049831E-08	2.9108952E-09
4.6341392E-12	5.1199325E-09	1.1825976E-09	1.2279622E-10
6.9937630E-16	8.3408895E-21	4.0910263E-14	2.7221195E-13
7.6219374E-17	2.9473623E-17	1.0795809E-13	1.4258721E-14
1.2953820E-19	4.3777933E-17	7.7983825E-19	1.0940026E-22
1.0488611E-22	1.4240791E-24	3.3224272E-28	4.8839851E-25

TEMPERATURE = 4000.0000 PRESSURE =1000.00000 MOLES OF GAS =

7.5284320E-07	4.8735880E-02	9.5054561E-01	2.7637475E-06
1.3073438E-08	1.9707087E-05	7.6591073E-05	1.2436173E-06
9.0868179E-08	4.8424160E-08	4.2935799E-08	9.3334469E-09
1.7804365E-13	1.6769202E-09	1.1839091E-09	1.7669553E-10
1.5571872E-14	1.3687233E-18	2.9744561E-15	8.0889117E-14
1.7213748E-15	1.3140483E-18	2.9167358E-14	1.2029086E-14
1.1063464E-20	1.0987277E-17	3.2173590E-19	4.8375232E-24
2.6135172E-23	5.9132953E-25	1.3855498E-29	9.9007195E-26

TEMPERATURE = 3000.0000 PRESSURE =1000.00000 MOLES OF GAS =

6.3001967E-10	4.9403409E-03	9.9423338E-01	8.7506721E-09
4.0615928E-12	2.1424413E-07	9.4261761E-06	1.0863884E-07
6.0877171E-10	6.5538238E-10	2.4565944E-09	1.9351740E-09
1.0853065E-17	3.4895895E-12	1.4660439E-11	3.6202686E-12
2.2773585E-14	2.4915266E-17	1.8606161E-19	5.0493031E-17
1.0292138E-15	1.2383232E-23	5.4927478E-18	1.4038388E-17
1.0780440E-25	6.4808208E-22	4.3336055E-23	5.5066028E-30
1.9100039E-28	1.0084724E-29	1.8048514E-35	1.8179702E-31

C/H Mass Ratio = 0.005

0.54983 MOLES OF SOLID = 0.

2.2372672E-05	3.0748924E-04	5.7601377E-05
4.6220596E-07	2.4082521E-09	5.6470738E-08
6.6779710E-08	5.0661474E-11	1.0759239E-13
3.1461503E-11	6.6041815E-13	2.6974008E-14
4.8592740E-13	3.4367130E-13	2.6949331E-13
2.3171229E-15	1.0820964E-16	4.3312964E-19
3.1339083E-20	7.4537364E-21	7.9562562E-25
1.0190934E-25		

0.51205 MOLES OF SOLID = 0.

4.9695420E-06	3.5877042E-04	2.5173535E-04
1.7862147E-06	2.2585198E-08	4.8135584E-09
2.9240509E-07	4.7633578E-10	2.2601641E-12
9.2259378E-11	2.3619457E-12	2.3021661E-13
2.1088734E-13	3.9407361E-13	6.6444550E-13
2.8366195E-15	2.4661458E-16	1.9125309E-17
7.6631311E-21	5.4864886E-21	7.6428874E-26
6.2476830E-26		

0.50065 MOLES OF SOLID = 0.

1.1286554E-07	1.1752381E-04	6.9740314E-04
1.4295878E-06	7.0179210E-08	2.9159197E-12
9.6309165E-08	5.2664719E-10	8.4631023E-12
5.8439403E-12	1.9775611E-13	7.6673726E-14
2.4782394E-16	1.9662542E-15	1.1201792E-14
5.5853842E-18	1.2907854E-18	1.2375401E-17
1.5310175E-25	6.4018871E-25	1.1094074E-31
6.7469947E-31		

C/H Mass Ratio = 0.005

TEMPERATURE = 2200.0000 PRESSURE =1000.00000 MOLES OF GAS =

6.0049317E-15	1.7695962E-04	9.9898342E-01	5.4327313E-13
2.5482506E-18	2.2075201E-11	3.7425108E-08	2.4399824E-10
9.7805294E-15	3.1984242E-14	8.8271710E-13	4.6616221E-12
5.2471869E-26	3.0433977E-18	1.7183838E-16	8.6263323E-17
3.1409491E-16	6.2551189E-18	2.7619709E-28	2.2503675E-24
1.0788253E-18	3.3718373E-34	1.2704225E-26	4.6307609E-25
1.8048514E-35	8.1962186E-32	1.9823844E-32	1.8048514E-35
1.8048514E-35	1.8048514E-35	1.8048514E-35	1.8048514E-35

TEMPERATURE = 1600.0000 PRESSURE =1000.00000 MOLES OF GAS =

3.8632079E-22	1.7164591E-06	9.9915874E-01	4.7160040E-19
2.5531404E-27	2.1248701E-17	9.2784643E-12	2.6282724E-14
7.4382666E-22	1.3012087E-20	5.5865669E-18	4.5383790E-16
1.8048514E-35	3.0003007E-27	6.7854902E-24	9.2484857E-24
3.4703681E-19	2.0996559E-19	1.8048514E-35	2.5993429E-35
2.1953436E-23	1.8048514E-35	1.8048514E-35	1.8048514E-35
1.8048514E-35	1.8048514E-35	1.8048514E-35	1.8048514E-35
1.8048514E-35	1.8048514E-35	1.8048514E-35	1.8048514E-35

C/H Mass Ratio = 0.005

```
0.49942     MOLES OF SOLID =  0.
     1.2396495E-10    6.1897842E-06    8.3342423E-04
     8.3164330E-08    3.1116682E-08    1.2415048E-18
     4.7196814E-10    1.5383262E-11    1.5459016E-12
     7.4402970E-16    3.9612595E-17    1.1557044E-16
     3.0644293E-23    1.7907777E-21    6.1936337E-20
     3.8845853E-25    3.8485005E-25    4.3012718E-21
     1.8048514E-35    6.4972638E-35    1.8048514E-35
     1.8048514E-35
```

```
0.49937     MOLES OF SOLID =  0.
     6.3511304E-15    7.4796022E-08    8.3990580E-04
     9.1498733E-10    6.7394158E-09    4.8829135E-28
     1.3398208E-13    5.6263525E-14    8.3399289E-14
     8.9947942E-22    9.9107105E-23    5.0400798E-21
     1.6925624E-33    1.5256412E-30    7.1069419E-28
     1.8048514E-35    5.6010555E-35    1.4284479E-26
     1.8048514E-35    1.8048514E-35    1.8048514E-35
     1.8048514E-35
```

G/H Mass Ratio = 0.01

TEMPERATURE =10000.0000 PRESSURE = 100.00000 MOLES OF GAS =

8.3453876E-04	9.8212484E-01	9.8927610E-03	7.6502283E-06
2.5063697E-08	1.9153266E-07	3.6493953E-12	2.1144839E-15
5.5826476E-15	3.4971848E-17	4.4765239E-20	3.1539410E-23
5.1314327E-19	3.0504877E-19	2.0563915E-22	3.4266571E-25
1.8048514E-35	1.8048514E-35	2.7640134E-24	3.3590370E-26
1.8048514E-35	2.3505090E-29	2.6807661E-29	1.2715846E-32
7.7299725E-35	2.1982276E-35	1.8048514E-35	1.8048514E-35
1.8048514E-35	1.8048514E-35	1.8048514E-35	1.8048514E-35
8.0846483E-08	3.5027426E-03	6.2868577E-05	6.4845344E-05
5.5015997E-11			

TEMPERATURE = 8000.0000 PRESSURE = 100.00000 MOLES OF GAS =

8.3923538E-04	9.6331452E-01	3.5057426E-02	2.3496491E-05
1.6323096E-07	1.3044425E-07	5.9526275E-10	8.1244982E-13
1.9689119E-12	2.9370065E-14	1.4901519E-16	3.2727034E-19
1.7270658E-16	6.1216807E-16	1.8730117E-18	8.0630585E-21
1.9012322E-33	1.8048514E-35	7.9657626E-21	5.0125676E-22
4.5890977E-34	1.7343185E-25	2.9567915E-24	5.2346263E-27
4.0199394E-30	1.7764652E-29	1.2572438E-32	1.2745409E-34
1.8048514E-35	1.8048514E-35	1.8048514E-35	1.8048514E-35
2.1936709E-08	3.6261642E-04	1.4087757E-05	1.4182935E-05
1.9658603E-10			

TEMPERATURE = 6500.0000 PRESSURE = 100.00000 MOLES OF GAS =

8.5892369E-04	8.6073645E-01	1.3825454E-01	7.9035382E-05
1.4486538E-06	4.9309757E-06	1.5167651E-07	4.0768626E-10
1.2052626E-09	4.1915108E-11	7.6564288E-13	5.0324249E-15
1.2903262E-13	2.8699119E-12	3.3225134E-14	3.4344953E-16
9.3618813E-27	2.2400313E-34	6.9900987E-17	1.8459739E-17
5.4357502E-27	3.5921431E-21	8.7633842E-19	5.7291661E-21
2.2845579E-24	4.2034302E-23	7.0516290E-26	3.9054106E-28
1.2380519E-30	1.5626780E-33	1.8048514E-35	7.7104141E-34
4.4448480E-09	2.5997272E-05	2.1307869E-06	2.3189187E-06
7.1594885E-10			

C/H Mass Ratio = 0.01

0.99358 MOLES OF SOLID = 0.

1.1775482E-08	1.9754888E-10	1.0197000E-13
2.5967081E-19	1.9762407E-24	4.5564724E-13
1.3630828E-23	7.4901259E-29	4.0734947E-35
7.3731269E-28	3.1055019E-31	8.6495497E-35
9.6859759E-28	2.7255215E-30	1.8826060E-32
3.0741256E-35	1.8048514E-35	1.8048514E-35
1.8048514E-35	1.8048514E-35	1.8048514E-35
1.8048514E-35	3.5070426E-03	8.6004853E-07
1.1007730E-06	4.4357576E-07	2.3659863E-11

0.96643 MOLES OF SOLID = 0.

1.4186350E-07	1.1632726E-08	2.2942743E-11
3.0585397E-15	2.3275352E-20	4.1462592E-11
3.5765501E-19	6.4963025E-24	2.3864293E-29
5.3886169E-23	6.2953872E-26	5.3174676E-29
4.0577603E-23	4.2346610E-25	8.1203660E-27
3.4636286E-29	4.8342890E-32	1.8048514E-35
1.7593931E-34	1.8048514E-35	1.8048514E-35
1.8048514E-35	3.6832481E-04	3.9367661E-06
1.4074936E-06	2.9194964E-07	3.6664559E-10

0.87848 MOLES OF SOLID = 0.

1.8706502E-06	7.7548348E-07	6.1271388E-09
6.0911198E-12	2.8634609E-16	6.4899291E-09
1.2405262E-14	6.6420082E-19	1.3746392E-23
6.5299727E-18	1.6377489E-20	4.2725777E-23
3.4412080E-18	1.3120328E-19	7.2657170E-21
9.1999974E-23	3.4656346E-25	1.8381837E-30
3.4036857E-27	4.1492453E-29	1.5297840E-31
1.8048514E-35	2.8806520E-05	7.0939850E-07
1.7466580E-06	1.8310327E-07	6.9904920E-09

C/I. Mass Ratio = 0.01

TEMPERATURE = 5000.0000 PRESSURE = 100.00000 MOLES OF GAS =

3.3507757E-04	4.6567537E-01	5.3340882E-01	1.3045657E-04
6.6086357E-06	2.9463023E-04	6.4797906E-05	3.0128658E-07
1.1265296E-06	1.0009360E-07	8.6198543E-09	2.1333880E-10
9.5493054E-11	2.6955793E-08	1.5907805E-09	4.2203021E-11
2.6169557E-19	2.0373638E-25	1.0100332E-12	1.7171005E-12
5.2345628E-19	8.7184168E-16	8.1591402E-13	2.7533100E-14
4.5909495E-18	3.9641054E-16	1.8041795E-18	4.6454090E-21
1.3633572E-21	4.7294499E-24	2.0251741E-26	7.6061786E-24

TEMPERATURE = 4000.0000 PRESSURE 100.00000 MOLES OF GAS =

1.6557552E-05	1.4600086E-01	8.5307288E-01	1.8209447E-05
6.3237300E-07	2.8557010E-04	3.3248711E-04	1.6172989E-06
2.8959709E-06	4.6232874E-07	1.2280466E-07	7.9973128E-09
4.1657535E-11	1.1754028E-07	2.4859883E-08	1.1115085E-09
2.3635306E-16	1.8644446E-21	1.5306163E-12	1.2469688E-11
6.4028628E-16	1.4871756E-15	9.3890605E-12	1.2217929E-12
2.7538093E-17	8.1929410E-15	7.1871365E-17	2.6482391E-20
9.4266707E-20	6.3895213E-22	3.6689323E-25	7.8540118E-22

TEMPERATURE = 3000.0000 PRESSURE = 100.00000 MOLES OF GAS =

4.2943775E-08	1.5536383E-02	9.8327417E-01	1.8757750E-07
1.8870711E-09	3.1303587E-05	4.3312578E-04	1.5698441E-06
6.0629734E-07	2.0526693E-07	2.4196396E-07	5.9941921E-08
2.3428062E-13	2.3689261E-08	3.1298035E-08	2.4305470E-09
4.7028488E-14	5.0884029E-18	2.7377029E-14	2.3364350E-12
1.4648524E-13	1.2419679E-17	1.7324421E-12	1.3924507E-12
7.3698285E-19	1.3932994E-15	2.9299307E-17	2.5659743E-22
1.9078362E-20	3.1678483E-22	3.7926958E-27	1.2377630E-22

C/H Mass Ratio = 0.01

```
0.65165     MOLES OF SOLID =  0.
     1.7498027E-05    6.1444976E-05    2.9408627E-06
     2.8273409E-08    9.6164557E-12    9.7123759E-07
     1.2504697E-09    2.4237715E-13    3.3602090E-17
     2.7626350E-12    1.4816595E-14    1.5461797E-16
     7.8315064E-13    1.4151496E-13    2.8352579E-14
     1.1431647E-15    1.3639900E-17    3.5639690E-21
     3.3999864E-19    2.0660936E-20    4.0477635E-23
     4.0550038E-25
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0.53893     MOLES OF SOLID =  0.
     9.8089250E-06    2.1214278E-04    4.4592588E-05
     6.9589522E-07    7.8967307E-10    5.1208459E-07
     7.5057443E-08    3.6629294E-11    1.5597979E-14
     1.7386179E-10    1.3334317E-12    3.8935335E-14
     9.7391808E-12    5.4520029E-12    2.7538768E-12
     8.6312213E-14    2.2480011E-15    1.5645853E-17
     1.2567481E-17    2.6955232E-18    9.2020074E-22
     1.4847392E-22
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0.50320     MOLES OF SOLID =  0.
     7.6084073E-07    2.4914457E-04    4.6494605E-04
     6.4964418E-06    3.1539861E-08    9.2345099E-09
     9.3814895E-07    1.6133064E-09    2.5639723E-12
     1.2338516E-09    1.3130461E-11    1.6009934E-12
     3.6062749E-12    8.9980317E-12    1.6120917E-11
     1.7422415E-13    1.2661998E-14    1.2005878E-14
     2.2435771E-18    2.9502728E-18    3.5237575E-23
     1.4446206E-22
```

C/H Mass Ratio = 0.01

TEMPERATURE = 2200.0000 PRESSURE = 100.00000 MOLES OF GAS =

1.1615412E-12	5.5925766E-04	9.9777790E-01	3.3211055E-11
9.5344442E-15	2.6103301E-08	1.3985943E-05	2.8817308E-08
2.2370719E-10	2.3120188E-10	2.0165758E-09	3.3656411E-09
7.3457076E-20	1.3464861E-12	2.4027129E-11	3.8119362E-12
4.3759238E-14	8.7040235E-17	7.4791425E-21	1.9258544E-17
2.9107934E-14	1.7661407E-25	2.1030317E-18	2.4226359E-17
9.1372375E-27	2.6244533E-22	2.0060942E-23	1.1630260E-31
1.2138362E-28	7.5423266E-30	1.8048514E-35	8.8748274E-32

TEMPERATURE = 1600.0000 PRESSURE = 100.00000 MOLES OF GAS =

7.7441283E-20	5.4256239E-06	9.9831367E-01	2.9882413E-17
1.0259454E-23	2.6989717E-14	3.7252741E-09	3.3355613E-12
1.8939203E-17	1.0472591E-16	1.4212426E-14	3.6495553E-13
5.0602459E-32	1.5313711E-21	1.0947448E-18	4.7164741E-19
5.5847639E-17	3.3760654E-18	7.7857236E-34	2.6595276E-28
7.0880085E-19	1.8048514E-35	3.6761921E-31	1.8218850E-28
1.8048514E-35	1.8048514E-35	1.8048514E-35	1.8048514E-35
1.8048514E-35	1.8048514E-35	1.8048514E-35	1.8048514E-35

C/H Mass Ratio = 0.01

```
0.49891     MOLES OF SOLID =  0.
     2.3949749E-09    3.7793360E-05    1.6082142E-03
     3.1041408E-06    1.1600413E-07    8.9852028E-14
     1.0769158E-07    1.1093154E-09    1.1134337E-11
     1.0390773E-11    1.7483517E-13    1.6120570E-13
     8.2881525E-17    1.5306939E-15    1.6731324E-14
     6.4227018E-18    2.0109531E-18    2.2448304E-15
     7.3310934E-26    1.2717935E-24    1.8889580E-32
     1.3787147E-30
```

```
0.49874     MOLES OF SOLID =  0.
     1.2720615E-13    4.7353500E-07    1.6808171E-03
     3.6705390E-08    2.7012794E-08    3.9332632E-23
     3.4056648E-11    4.5206299E-12    6.6952511E-13
     1.4499603E-17    5.0499288E-19    8.1177243E-18
     5.4739495E-27    1.5596434E-24    2.2965277E-22
     1.4015849E-28    3.6281402E-28    9.2450784E-21
     1.8048514E-35    1.8048514E-35    1.8048514E-35
     1.8048514E-35
```

C/H Mass Ratio = 0.01

TEMPERATURE =10000.0000 PRESSURE = 500.00000 MOLES OF GAS =

8.2834570E-04	9.4952835E-01	4.6234908E-02	3.6707156E-05
1.2346541E-07	4.5609376E-06	4.2009102E-10	1.1766248E-12
6.5976062E-13	1.9979102E-14	1.2362597E-16	4.2104980E-19
6.2259957E-17	1.7891657E-16	5.8304006E-19	4.6965024E-21
1.5992135E-32	1.8048514E-35	1.6643521E-21	9.7775751E-23
4.2732445E-34	7.0242813E-26	3.8726692E-25	8.8798914E-28
1.1464455E-30	1.5760109E-30	2.1947504E-33	4.9270396E-35
1.8048514E-35	1.8048514E-35	1.8048514E-35	1.8048514E-35
1.7721129E-07	1.5335020E-03	1.3422703E-04	1.3723538E-04
5.9848639E-10			

TEMPERATURE = 8000.0000 PRESSURE = 500.00000 MOLES OF GAS =

8.3717048E-04	8.5922246E-01	1.3945211E-01	1.0452993E-04
8.12 4371E-07	2.8944275E-06	5.8905227E-08	3.5854945E-10
2.170351E-10	1.4742855E-11	3.2800718E-13	3.2126760E-15
2.1376641E-14	3.3791590E-13	4.6109011E-15	8.8522285E-17
3.6823489E-26	7.8996775E-34	4.9176560E-18	1.3800617E-18
2.2289624E-27	5.3402285E-22	4.0603077E-20	3.2057646E-22
6.1737705E-26	1.2167320E-24	3.8403023E-27	9.7630372E-30
1.3073802E-32	3.0818398E-35	1.8048514E-35	1.8048514E-35
4.7713485E-08	1.4833564E-04	2.7398004E-05	2.5874475E-05
2.1326639E-09			

TEMPERATURE = 6500.0000 PRESSURE = 500.00000 MOLES OF GAS =

7.0948445E-04	6.2933735E-01	3.6955241E-01	2.3866738E-04
4.9420950E-06	6.1498243E-05	6.9156250E-06	6.7955151E-08
6.2082561E-08	7.8929947E-09	5.2708520E-10	1.2665287E-11
7.5086608E-12	6.1054066E-10	2.5840221E-11	9.7650750E-13
1.7381710E-20	5.5584020E-27	1.6799813E-14	1.6219216E-14
3.1187488E-21	8.5286622E-18	3.1800535E-15	7.6004122E-17
9.3656874E-21	6.2997699E-19	3.3636097E-21	6.6124508E-24
3.1650200E-25	1.4604613E-27	4.3936015E-30	8.1409099E-28
8.9670500E-09	7.7828131E-06	3.8050278E-06	2.5379181E-06
5.9653105E-09			

C/I Mass Ratio = 0.01

0.95704 MOLES OF SOLID = 0.

2.7312799E-07	2.2149966E-08	5.5269063E-11
6.9850246E-15	1.2422438E-19	1.1139454E-11
8.7965633E-19	2.3366358E-23	2.9695528E-28
4.8850241E-23	9.9462117E-26	1.3391552E-28
1.3629209E-23	1.8539090E-25	6.1902604E-27
1.0377576E-29	2.3705091E-32	1.8048514E-35
1.8048514E-35	1.8048514E-35	1.8048514E-35
1.8048514E-35	1.5489456E-03	3.8656541E-07
1.1261495E-05	9.6378241E-07	1.2012841E-09

0.87761 MOLES OF SOLID = 0.

2.8145939E-06	1.0292815E-06	9.0532689E-09
6.0196882E-12	9.1111146E-16	1.0289329E-09
1.5657863E-14	1.2683575E-18	9.2669914E-23
2.6383814E-18	1.3746446E-20	5.1782126E-23
4.9823259E-19	2.3188457E-20	1.9830620E-21
9.4598558E-24	5.8883485E-26	3.0840482E-31
6.0103691E-29	9.0497687E-31	1.5454668E-33
1.8048514E-35	1.6062033E-04	1.8010686E-06
1.1451413E-05	5.9567040E-07	1.4878515E-08

0.72988 MOLES OF SOLID = 0.

2.0651306E-05	3.1297587E-05	9.0402203E-07
3.7117337E-09	2.3320489E-12	9.1441797E-08
1.1413708E-10	2.2341065E-14	6.1795890E-18
6.7874599E-14	6.2233840E-16	5.9354357E-18
1.1053464E-14	1.5406916E-15	3.1191227E-16
4.4618689E-18	6.1446227E-20	4.3557997E-24
2.1068255E-22	9.3892556E-24	1.0697545E-26
3.1674141E-29	1.4071013E-05	2.3992420E-07
6.9884880E-06	2.2639305E-07	1.1551579E-07

C/F Mass Ratio = 0.01

TEMPERATURE = 5000.0000 PRESSURE = 500.00000 MOLES OF GAS =

8.9846005E-05	2.4723244E-01	7.5175200E-01	9.2856342E-05
2.3756838E-06	2.8115538E-04	1.6414292E-04	2.0259708E-06
1.4412359E-06	3.3993110E-07	7.7709941E-08	5.1055046E-09
6.1701463E-11	4.6234691E-08	7.2429966E-09	5.1008629E-10
4.1692424E-16	2.2872516E-21	8.7494901E-13	3.9485271E-12
1.5866430E-16	1.0125305E-15	2.5153993E-12	2.2532523E-13
7.1481940E-18	1.6384420E-15	1.9795100E-17	9.6970878E-21
1.0128442E-20	9.3268694E-23	7.5984749E-26	7.5756979E-23

TEMPERATURE = 4000.0000 PRESSURE = 500.00000 MOLES OF GAS =

3.0440076E-06	6.8196478E-02	9.3061324E-01	7.8184900E-06
1.0686672E-07	1.1270897E-04	3.0647643E-04	3.4816811E-06
1.0506534E-06	3.9173535E-07	2.4301502E-07	3.6960584E-08
5.9484220E-12	3.9198685E-08	1.9362452E-08	2.0218570E-09
2.9873170E-14	1.2853540E-18	2.0090653E-13	3.8226100E-12
1.3638315E-14	1.7943603E-16	2.7866269E-12	8.0407764E-13
3.0542240E-18	2.1221839E-15	4.3478633E-17	2.6998747E-21
2.0631953E-20	3.2660822E-22	3.1605664E-26	1.5801319E-22

TEMPERATURE = 3000.0000 PRESSURE = 500.00000 MOLES OF GAS =

4.2112072E-09	6.9769766E-03	9.9146880E-01	4.1302297E-08
9.0734249E-11	3.3795900E-06	1.0499561E-04	8.5447839E-07
3.2094629E-08	2.4397935E-08	6.4576124E-08	3.5920214E-08
2.7081478E-15	6.1485697E-10	1.8240089E-09	3.1805423E-10
3.5123204E-13	1.9159712E-16	1.5516681E-16	2.9734026E-14
1.0639598E-13	3.4514309E-20	1.0810223E-14	1.9509369E-14
1.0042057E-21	4.2628226E-18	2.0127825E-19	1.7143264E-25
1.4032910E-23	5.2318743E-25	6.0917637E-31	4.4639618E-26

C/H Mass Ratio = 0.01

```
0.57010     MOLES OF SOLID =  0.
     3.3061829E-05    3.0818851E-04    3.9155867E-05
     5.0468868E-07    1.2096089E-09    4.6808605E-07
     7.9439059E-08    4.0873784E-11    3.9930387E-14
     8.8637127E-11    1.2619227E-12    3.4957197E-14
     4.7805381E-12    2.2931159E-12    1.2195744E-12
     2.4834517E-14    7.8659316E-16    1.4482957E-18
     1.8840239E-18    3.0391456E-19    1.1328068E-22
     1.0721113E-23
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0.51698     MOLES OF SOLID =  0.
     9.8361249E-06    4.9682949E-04    2.4390360E-04
     3.4987981E-06    2.1655855E-08    7.9548208E-08
     8.1014895E-07    9.2337061E-10    2.1447122E-12
     7.3861546E-10    1.3230053E-11    9.0221725E-13
     6.9727356E-12    9.1161915E-12    1.0754203E-11
     1.3266276E-13    8.0695642E-15    3.0634146E-16
     2.9923392E-18    1.4989338E-18    8.6235999E-23
     6.9763616E-23
```

```
0.50067     MOLES OF SOLID =  0.
     3.7616170E-07    2.7657914E-04    1.1589316E-03
     7.9397568E-06    1.9434150E-07    2.1770743E-10
     1.2623133E-06    4.8741580E-09    3.9054416E-11
     3.6253252E-10    8.6626674E-12    2.3716385E-12
     1.0304956E-13    5.7732761E-13    2.3224759E-12
     5.4809905E-15    8.9441779E-16    4.2756930E-15
     3.3656559E-21    9.9375046E-21    1.1543140E-26
     1.1698352E-25
```

C/H Mass Ratio = 0.01

TEMPERATURE = 2200.0000 PRESSURE = 500.00000 MOLES OF GAS =

4.7956968E-14	2.5014427E-04	9.9807020E-01	3.0665375E-12
8.1264189E-17	4.9756323E-10	5.9620164E-07	2.7472817E-09
8.8027833E-13	2.0346037E-12	3.9687360E-11	1.4813369E-10
2.6681567E-23	1.0937770E-15	4.3649287E-14	1.5487100E-14
9.9457314E-15	9.8942848E-17	5.6081180E-25	3.2295201E-21
2.7306612E-16	2.7338753E-30	7.2802579E-23	1.8755917E-21
2.9198053E-32	1.8755430E-27	3.2061798E-28	1.8048514E-35
3.6967796E-35	1.8048514E-35	1.8048514E-35	1.8048514E-35

TEMPERATURE = 1600.0000 PRESSURE = 500.00000 MOLES OF GAS =

3.0982479E-21	2.4264161E-06	9.9831629E-01	2.6732791E-18
8.2107092E-26	4.8299276E-16	1.4906845E-10	2.9845691E-13
6.7797923E-20	8.3828917E-19	2.5438631E-16	1.4606688E-14
1.8048514E-35	1.0966034E-24	1.7529417E-21	1.6887193E-21
1.1178202E-17	3.3786953E-18	1.8048514E-35	3.8096623E-32
5.6758924E-21	1.8048514E-35	1.8048514E-35	1.1673458E-32
1.8048514E-35	1.8048514E-35	1.8048514E-35	1.8048514E-35
1.8048514E-35	1.8048514E-35	1.8048514E-35	1.8048514E-35

C/H Mass Ratio = 0.01

```
0.49881     MOLES OF SOLID =  0.
     4.9455587E-10    1.7453335E-05    1.6609457E-03
     6.6182033E-07    1.2369982E-07    1.5809552E-16
     1.0600251E-08    2.4419582E-10    1.2258700E-11
     9.4410585E-14    3.5526287E-15    7.3257146E-15
     3.1082837E-20    1.2838055E-18    3.1382647E-17
     1.1120294E-21    7.7866177E-22    4.3473843E-18
     1.0815419E-31    4.1960557E-30    1.8048514E-35
     1.8048514E-35
```

```
0.49874     MOLES OF SOLID =  0.
     2.5446179E-14    2.1181264E-07    1.6811477E-03
     7.3439276E-09    2.7023346E-08    6.2968403E-26
     3.0478887E-12    9.0465251E-13    6.6991647E-13
     1.1608635E-19    9.0405675E-21    3.2495987E-19
     1.7533449E-30    1.1170643E-27    3.6779848E-25
     2.0081024E-32    1.1623386E-31    1.4809203E-23
     1.8048514E-35    1.8048514E-35    1.8048514E-35
     1.8048514E-35
```

C/H Mass Ratio = 0.01

TEMPERATURE =10000.0000 PRESSURE =1000.00000 MOLES OF GAS =

8.0453745E-04	9.1139128E-01	8.5191032E-02	6.8440368E-05
2.3294029E-07	1.6518872E-05	2.9207648E-09	1.5704280E-11
4.6417027E-12	2.6983226E-13	3.2051937E-15	2.0955861E-17
4.4323850E-16	2.4451533E-15	1.5296103E-17	2.3652858E-19
2.0996673E-29	1.8048514E-35	2.3016464E-20	2.5956815E-21
2.9574183E-31	1.8869473E-24	1.9970786E-23	8.7906153E-26
5.9824108E-29	1.5787323E-28	4.2204785E-31	4.9942833E-33
1.8048514E-35	1.8048514E-35	1.8048514E-35	1.8048514E-35
2.4068686E-07	1.0525795E-03	1.8016204E-04	1.8082714E-04
1.5789919E-09			

TEMPERATURE = 8000.0000 PRESSURE =1000.00000 MOLES OF GAS =

8.0693425E-04	7.7296877E-01	2.2571880E-01	1.8128056E-04
1.5090769E-06	9.6767037E-06	3.5432757E-07	3.8804895E-09
1.4043750E-09	1.7095697E-10	6.8434469E-12	1.2059928E-13
1.4761362E-13	4.1983808E-12	1.0307310E-13	3.5603975E-15
2.7925585E-23	1.9393623E-30	6.5463498E-17	3.3054143E-17
1.0066109E-24	1.3704245E-20	1.8747379E-18	2.6631730E-20
3.0542176E-24	1.0830058E-22	6.1501737E-25	9.3108356E-28
4.3246064E-30	1.8341753E-32	5.5757297E-35	3.5431696E-33
6.5271170E-08	9.4025536E-05	3.4980918E-05	2.9509251E-05
5.6241499E-09			

TEMPERATURE = 6500.0000 PRESSURE =1000.00000 MOLES OF GAS =

5.3207278E-04	5.1119851E-01	4.8766119E-01	2.9077517E-04
5.5590102E-06	1.1237899E-04	2.0530047E-05	3.2773060E-07
1.7015717E-07	3.5144579E-08	3.8127083E-09	1.4883456E-10
1.9000508E-11	2.5098823E-09	1.7257230E-10	1.0594651E-11
2.1339465E-18	1.8009980E-24	6.3762497E-14	1.0000616E-13
2.1759944E-19	4.8551195E-17	2.9409623E-14	1.1419008E-15
7.9968104E-20	8.7385190E-18	8.7064801E-20	8.4683331E-23
9.8765731E-24	7.4038172E-26	1.2658207E-28	3.8103116E-26
1.0660140E-08	3.9880230E-06	4.8994686E-06	2.1126848E-06
1.0636641E-08			

C/H Mass Ratio = 0.01

0.92213 MOLES OF SOLID = 0.

9.7758541E-07	1.5219082E-07	7.2899495E-10
1.7896782E-13	1.1729182E-17	4.0825157E-11
8.4044932E-17	4.2856491E-21	2.0071073E-25
4.7228360E-21	1.8459525E-23	4.7711228E-26
6.9457349E-22	1.8136873E-23	1.1625461E-24
1.9721230E-27	8.6478312E-30	1.8048514E-35
2.0879099E-33	1.8048514E-35	1.8048514E-35
1.8048514E-35	1.0830103E-03	2.6849192E-07
2.8485280E-05	1.2850328E-06	5.9024833E-09

0.81571 MOLES OF SOLID = 0.

8.7823882E-06	5.7785296E-06	9.1448143E-08
1.1721894E-10	5.7433826E-14	3.6856974E-09
1.0575398E-12	1.5413162E-16	3.6455402E-20
1.9092807E-16	1.7898183E-18	1.2130663E-20
2.1470673E-17	1.7979265E-18	2.7664453E-19
1.4139642E-21	1.5835571E-23	2.6849366E-28
1.0313141E-26	2.7939166E-28	2.8413074E-31
8.3564591E-35	1.1397943E-04	1.2232028E-06
2.3498063E-05	7.2788134E-07	5.8855461E-08

0.67174 MOLES OF SOLID = 0.

4.0874065E-05	1.0063458E-04	4.7222776E-06
2.9080873E-08	4.8221467E-11	1.5427275E-07
2.1789718E-09	6.9289041E-13	5.0581568E-16
1.1963390E-12	1.7820078E-14	2.7610345E-16
1.1072138E-13	2.5071761E-14	8.2458907E-15
1.0890405E-16	2.4364532E-18	4.5583030E-22
4.3832884E-21	3.1735028E-22	2.0548397E-25
2.4083988E-27	1.1152711E-05	1.1350557E-07
9.4509703E-06	1.7399720E-07	2.3431099E-07

C/I. Mass Ratio = 0.01

TEMPERATURE = 5000.0000 PRESSURE =1000.00000 MOLES OF GAS =

4.4962558E-05	1.8221064E-01	8.1665977E-01	6.8495510E-05
1.1899347E-06	2.0757697E-04	1.7862951E-04	3.2498441E-06
1.0650010E-06	3.7025781E-07	1.2476369E-07	1.2082269E-08
3.0959533E-11	3.4195211E-08	7.8961211E-09	8.1966721E-10
4.6616772E-15	5.5564211E-20	4.3940375E-13	2.9229031E-12
8.1724327E-16	5.0894563E-16	1.8636684E-12	2.4607626E-13
3.5961857E-18	1.2149972E-15	2.1637161E-17	4.8828005E-21
7.5240343E-21	1.0212748E-22	3.8328202E-26	5.6326538E-23

TEMPERATURE = 4000.0000 PRESSURE =1000.00000 MOLES OF GAS =

1.2835649E-06	4.8720217E-02	9.4993476E-01	4.7105570E-06
3.8002896E-08	5.7267723E-05	2.2249787E-04	3.6115613E-06
4.5020778E-07	2.3984104E-07	2.1258913E-07	4.6198109E-08
1.5044585E-12	1.4165345E-08	9.9975420E-09	1.4916281E-09
1.3124360E-13	1.1528522E-17	4.2852373E-14	1.1649783E-12
2.4751702E-14	3.2276931E-17	7.1620709E-13	2.9523066E-13
4.6332445E-19	4.5998594E-16	1.3465257E-17	3.4540650E-22
3.1805852E-21	7.1940064E-23	2.8757873E-27	2.0542921E-23

TEMPERATURE = 3000.0000 PRESSURE =1000.00000 MOLES OF GAS =

1.2301635E-09	4.9383427E-03	9.9342930E-01	1.7079471E-08
1.5485093E-11	8.1648941E-07	3.5908855E-05	4.1369038E-07
4.5300710E-09	4.8749413E-09	1.8265538E-08	1.4382799E-08
1.5775650E-16	5.0702945E-11	2.1292675E-10	5.2559162E-11
3.2995960E-13	3.6069778E-16	5.2808029E-18	1.4325145E-15
2.9140347E-14	6.8625628E-22	3.0427507E-16	7.7735308E-16
1.1665332E-23	7.0099650E-20	4.6855307E-21	1.1634655E-27
7.8765623E-26	4.1571037E-27	1.4111575E-33	1.4638560E-28

C/H Mass Ratio = 0.01

```
0.54956     MOLES OF SOLID =  0.
     3.5948079E-05    4.9392782E-04    9.2500107E-05
     1.1933043E-06    6.2139690E-09    2.3466177E-07
     2.7710362E-07    2.1016057E-10    4.4607357E-13
     2.0994608E-10    4.4057825E-12    1.7989756E-13
     5.2162017E-12    3.6880942E-12    2.8912288E-12
     3.9977368E-14    1.8664090E-15    7.4663832E-18
     1.3983396E-18    3.3248814E-19    5.7090753E-23
     1.1749746E-23

0.51168     MOLES OF SOLID =  0.
     8.4674131E-06    6.1109854E-04    4.2864668E-04
     5.1856394E-06    6.5525915E-08    2.3856498E-08
     1.4468632E-06    2.3562202E-09    1.1172843E-11
     7.7858483E-10    1.9926286E-11    1.9415703E-12
     3.0362580E-12    5.6718628E-12    9.5602261E-12
     6.9608656E-14    6.0498074E-15    4.6886895E-16
     5.4698439E-19    3.9149263E-19    9.3041749E-24
     1.2959088E-23

0.50007     MOLES OF SOLID =  0.
     2.2020071E-07    2.2919627E-04    1.3595334E-03
     5.4415864E-06    2.6691426E-07    2.1707096E-11
     7.1550918E-07    3.9110355E-09    6.2798643E-11
     8.4808190E-11    2.8687079E-12    1.1118013E-12
     7.0280562E-15    5.5738594E-14    3.1741560E-13
     3.0915633E-16    7.1417276E-17    6.8415944E-16
     3.2335108E-23    1.3515301E-22    4.5768715E-29
     5.4305713E-28
```

TEMPERATURE = 2200.0000 PRESSURE =1000.00000 MOLES OF GAS =

1.2035885E-14	1.7688513E-04	9.9814254E-01	1.0884419E-12
1.0237216E-17	8.8646489E-11	1.5022323E-07	9.7898908E-10
7.8720745E-14	2.5732373E-13	7.0987661E-12	3.7472730E-11
8.4684900E-25	4.9097015E-17	2.7709833E-15	1.3904561E-15
5.0521646E-15	1.0052786E-16	8.9344646E-27	7.2764542E-23
3.4809951E-17	2.1861784E-32	8.2334920E-25	2.9998949E-23
1.1719738E-34	1.0646818E-29	2.5740201E-30	1.8048514E-35
1.8048514E-35	1.8048514E-35	1.8048514E-35	1.8048514E-35

TEMPERATURE = 1600.0000 PRESSURE =1000.00000 MOLES OF GAS =

7.7459338E-22	1.7157357E-06	9.9831676E-01	9.4518495E-19
1.0264223E-26	8.5388762E-17	3.7270170E-11	1.0552918E-13
5.9932965E-21	1.0479919E-19	4.4975179E-17	3.6521246E-15
1.8048514E-35	4.8471283E-26	1.0957662E-22	1.4928777E-22
5.5900258E-18	3.3792512E-18	1.8048514E-35	8.4199482E-34
7.0963169E-22	1.8048514E-35	1.8048514E-35	1.8244319E-34
1.8048514E-35	1.8048514E-35	1.8048514E-35	1.8048514E-35
1.8048514E-35	1.8048514E-35	1.8048514E-35	1.8048514E-35

C/I: Mass Ratio = 0.01

```
0.49879     MOLES OF SOLID =  0.
     2.4825788E-10     1.2390727E-05     1.6676486E-03
     3.3353805E-07     1.2469120E-07     9.9967289E-18
     3.7923471E-09     1.2355516E-10     1.2405908E-11
     1.1987767E-14     6.3796768E-16     1.8604974E-15
     9.9045268E-22     5.7855244E-20     2.0001543E-18
     2.5154476E-23     2.4910308E-23     2.7817593E-19
     3.0817326E-34     1.6909208E-32     1.8048514E-35
     1.8048514E-35
```

```
0.49874     MOLES OF SOLID =  0.
     1.2723614E-14     1.4978039E-07     1.6812179E-03
     3.6722667E-09     2.7025594E-08     3.9360056E-27
     1.0777263E-12     4.5238234E-13     6.7000017E-13
     1.4513153E-20     1.5984250E-21     8.1253450E-20
     5.4803395E-32     4.9377843E-29     2.2992140E-26
     4.4384398E-34     3.6332209E-33     9.2580646E-25
     1.8048514E-35     1.8048514E-35     1.8048514E-35
     1.8048514E-35
```

C/H Mass Ratio = 0.05

TEMPERATURE =10000.0000 PRESSURE = 100.00000 MOLES OF GAS =

4.1503653E-03	9.7884635E-01	9.8268242E-03	3.7919448E-05
6.1990432E-07	4.7213944E-06	8.9659463E-11	5.1775870E-14
6.8439591E-13	4.2730067E-15	5.4513466E-18	3.8279332E-21
3.1390461E-16	1.8598428E-16	1.2495702E-19	2.0752633E-22
1.8048514E-35	1.8048514E-35	8.4038978E-21	1.0185013E-22
1.8048514E-35	3.5563157E-25	4.0424569E-25	1.9110835E-28
5.8164311E-30	1.6485373E-30	4.7332768E-34	2.5049196E-34
1.8048514E-35	1.8048514E-35	1.8048514E-35	1.8048514E-35
4.0167065E-07	3.4945151E-03	6.2596584E-05	6.4477077E-05
1.3593700E-09			

TEMPERATURE = 8000.0000 PRESSURE = 100.00000 MOLES OF GAS =

4.1711634E-03	9.6010033E-01	3.4823871E-02	1.1639248E-04
4.0322685E-06	3.2115914E-06	1.4606714E-08	1.9869595E-11
2.4093236E-10	3.6429519E-12	1.8113253E-14	3.9647972E-17
1.0539079E-13	3.7231702E-13	1.1353541E-15	4.8712360E-18
1.1295793E-30	1.8048514E-35	2.4159876E-17	1.5152207E-18
1.3642243E-30	2.6143849E-21	4.4423207E-20	7.8383276E-23
3.0118513E-25	1.3265366E-24	9.3568691E-28	4.7461488E-29
1.4153796E-32	1.8048514E-35	1.8048514E-35	1.8048514E-35
1.1120618E-07	3.5433332E-04	1.4321033E-05	1.3812718E-05
4.9531734E-09			

TEMPERATURE = 6500.0000 PRESSURE = 100.00000 MOLES OF GAS =

4.0706617E-03	8.5796551E-01	1.3736581E-01	3.7336322E-04
3.2537591E-05	1.1039598E-04	3.3848416E-06	9.0687153E-09
1.2788286E-07	4.4330328E-09	8.0715375E-11	5.2881880E-13
6.5094015E-11	1.4431440E-09	1.6653577E-11	1.7159451E-13
4.6025832E-24	1.0941875E-31	1.6712260E-13	4.3992336E-14
1.2747036E-23	9.7356224E-17	9.3976879E-15	6.4498969E-17
1.2268027E-19	2.2499666E-18	3.7623669E-21	9.9391627E-23
1.4884422E-24	1.8726727E-27	8.6958519E-29	4.3931997E-27
2.2132963E-08	2.4663519E-05	2.2315776E-06	2.1928678E-06
1.6805661E-08			

C/1 Mass Ratio = 0.05

0.99360 MOLES OF SOLID = 0.

5.8172022E-08	9.7265278E-10	5.0038416E-13
6.3371509E-17	4.7907814E-23	5.6046438E-11
1.6488483E-21	9.0301567E-27	4.8783070E-33
4.4504319E-25	1.8682291E-28	5.1860839E-32
2.9271022E-24	8.2090296E-27	5.6513153E-29
4.6047247E-31	2.1686357E-34	1.8048514E-35
1.8048514E-35	1.8048514E-35	1.8048514E-35
1.8048514E-35	3.5035653E-03	4.2814771E-06
1.0908677E-06	2.2008291E-06	1.1660749E-10

0.96656 MOLES OF SOLID = 0.

7.0039186E-07	5.7240117E-08	1.1251561E-10
7.4551244E-14	5.6355237E-19	5.0906916E-09
4.3184426E-17	7.8176751E-22	2.8527044E-27
3.2446285E-20	3.7779730E-23	3.1804588E-26
1.2225048E-19	1.2715445E-21	2.4301710E-23
5.1691289E-25	7.1906340E-28	1.8809513E-34
6.5297836E-29	2.1972323E-31	7.4866828E-33
1.8048514E-35	3.7567729E-04	1.9183554E-05
1.3661801E-06	1.4179011E-06	1.7688112E-09

0.87873 MOLES OF SOLID = 0.

8.8085053E-06	3.6398363E-06	2.8665963E-08
1.3505678E-10	6.3082656E-15	6.9082981E-07
1.2993768E-12	6.9347125E-17	1.4259907E-21
3.2520064E-15	8.1299343E-18	2.1141186E-20
8.1745142E-15	3.1066734E-16	1.7148607E-17
1.0324023E-18	3.8765330E-21	2.0429078E-26
8.6344012E-22	1.0491832E-23	1.8451154E-25
4.6604661E-29	3.0266568E-05	3.1998402E-06
1.6463965E-06	8.2325380E-07	3.1228038E-08

C/H Mass Ratio = 0.05

TEMPERATURE = 5000.0000 PRESSURE = 100.00000 MOLES OF GAS =

8.6677425E-04	4.6476812E-01	5.3133243E-01	3.3680587E-04
4.4221457E-05	1.9676670E-03	4.3190510E-04	2.0042886E-06
1.9461554E-05	1.7258150E-06	1.4833409E-07	3.6640712E-09
4.2757693E-09	1.2046134E-06	7.0951055E-08	1.8786473E-09
1.1536215E-17	8.9462657E-24	1.1698731E-10	1.9849615E-10
5.9924171E-17	2.6121687E-13	2.4398393E-10	8.2172207E-12
3.5581708E-15	3.0663567E-13	1.3928689E-15	9.3134139E-18
7.0568075E-18	2.4432205E-20	2.7168688E-22	1.0184174E-19

TEMPERATURE = 4000.0000 PRESSURE = 100.00000 MOLES OF GAS =

3.9057075E-05	1.4574174E-01	8.5004750E-01	4.2877443E-05
3.5186858E-06	1.5861651E-03	1.8434827E-03	8.9512368E-06
3.7943138E-05	6.0467015E-06	1.6032863E-06	1.0422428E-07
1.2897570E-09	3.6326991E-06	7.6695591E-07	3.4230458E-08
7.2144617E-15	5.6708634E-20	1.1178521E-10	9.0907978E-10
4.6266131E-14	2.5620260E-13	1.7006091E-09	2.0973730E-10
1.1190741E-14	3.3234810E-12	2.9102993E-14	2.5385508E-17
2.1277426E-16	1.4396518E-18	1.9569320E-21	4.1817299E-18

TEMPERATURE = 3000.0000 PRESSURE = 100.00000 MOLES OF GAS =

1.1174176E-07	1.5505918E-02	9.7942114E-01	4.8712847E-07
1.2776708E-08	2.1153012E-04	2.9210540E-03	1.0566459E-05
1.0660537E-05	3.6021337E-06	4.2377854E-06	1.0477709E-06
1.0739839E-11	1.0838277E-06	1.4291353E-06	1.1076631E-07
2.1222757E-12	2.2872683E-16	3.2656020E-12	2.7814948E-10
1.7268528E-11	3.8548050E-15	5.3665897E-10	4.3049359E-10
5.9520274E-16	1.1230513E-12	2.3570008E-14	5.3923136E-19
1.0411815E-16	1.7254301E-18	5.3963720E-23	1.7576767E-18

G/H Mass Ratio = 0.05

```
0.65034     MOLES OF SOLID =  0.
     4.5087466E-05     1.5801786E-04     7.5482743E-06
     1.8772048E-07     6.3599637E-11     1.6811531E-05
     2.1434845E-08     4.1465972E-12     5.7262830E-16
     1.2273777E-10     6.5698637E-13     6.8425963E-15
     9.0355518E-11     1.6295389E-11     3.2584267E-12
     3.4051141E-13     4.0549645E-15     1.0553973E-18
     6.8032297E-16     4.1261135E-17     2.0992334E-19
     5.4188107E-21
```

```
0.53735     MOLES OF SOLID =  0.
     2.3055901E-05     4.9775708E-04     1.0444324E-04
     3.8447243E-06     4.3473607E-09     6.7212856E-06
     9.7644320E-07     4.7567504E-10     2.0184005E-13
     5.3448149E-09     4.0919251E-11     1.1926951E-12
     7.0875712E-10     3.9605881E-10     1.9969938E-10
     1.4790373E-11     3.8453138E-13     2.6668078E-15
     1.2025559E-14     2.5747112E-15     2.0807261E-18
     7.8911989E-19
```

```
0.50105     MOLES OF SOLID =  0.
     1.9719866E-06     6.4447935E-04     1.2003491E-03
     4.3641125E-05     2.1104494E-07     1.6268963E-07
     1.6366466E-05     2.8089719E-08     4.4467089E-11
     5.6119531E-08     5.9604425E-10     7.2532974E-11
     4.2848005E-10     1.0670061E-09     1.9079033E-09
     5.3757969E-11     3.8992757E-12     3.6827352E-12
     4.7055617E-15     6.1756071E-15     1.9268316E-19
     2.0474011E-18
```

C/H Mass Ratio = 0.05

TEMPERATURE = 2200.0000 PRESSURE = 100.00000 MOLES OF GAS =

5.4739417E-12	5.5746517E-04	9.9139221E-01	1.5601057E-10
2.1175150E-13	5.7787278E-07	3.0862737E-04	6.3387244E-07
2.3338998E-08	2.4043601E-08	2.0903961E-07	3.4776632E-07
3.6232298E-17	6.6201770E-10	1.1775395E-08	1.8621948E-09
2.1036731E-11	4.1575743E-14	1.7385193E-17	4.4622822E-14
6.6370268E-11	1.9347197E-21	2.2963837E-14	2.6368940E-13
4.7170696E-22	1.3505260E-17	1.0290121E-18	2.8295276E-26
1.3872538E-22	8.5922693E-24	2.6204298E-31	4.7799172E-25

TEMPERATURE = 1600.0000 PRESSURE = 100.00000 MOLES OF GAS =

3.9504866E-19	5.4071663E-06	9.9153262E-01	1.5191955E-16
2.6698099E-22	6.9996220E-13	9.6284071E-08	8.5918140E-11
2.5056200E-15	1.3807919E-14	1.8675060E-12	4.7791855E-11
3.4267613E-29	1.0335046E-18	7.3631798E-16	3.1614748E-16
3.6802439E-14	2.2096472E-15	2.6896071E-30	9.1561756E-25
2.3990217E-15	1.8048514E-35	6.4563382E-27	3.1888049E-24
1.8048514E-35	5.5226691E-32	2.8060861E-32	1.8048514E-35
1.8048514E-35	1.8048514E-35	1.8048514E-35	1.8048514E-35

C/H Mass Ratio = 0.05

0.49426 MOLES OF SOLID = 0.

1.1214453E-08	1.7639995E-04	7.4822571E-03
6.8060584E-05	2.5271984E-06	9.4042519E-12
1.1091931E-05	1.1389018E-07	1.1358143E-09
5.0597984E-09	8.4863286E-11	7.7996897E-11
1.9142436E-13	3.5239823E-12	3.8395573E-11
6.9683212E-14	2.1747945E-14	2.4121905E-11
1.7778665E-20	3.0743411E-19	2.1657737E-26
7.4018725E-24		

0.49373 MOLES OF SOLID = 0.

6.4450464E-13	2.3910578E-06	8.4582099E-03
9.4224908E-07	6.8872437E-07	5.2214025E-21
4.4446340E-09	5.8796735E-10	8.6488965E-11
9.6860908E-15	3.3619913E-16	5.3859979E-15
1.8781494E-23	5.3330449E-21	7.8260267E-19
2.4448250E-24	6.3071359E-24	1.5962400E-16
1.8048514E-35	8.2019811E-34	1.8048514E-35
1.8048514E-35		

C/H Mass Ratio = 0.05

TEMPERATURE =10000.0000 PRESSURE = 500.00000 MOLES OF GAS =

3.9684053E-03	9.4644637E-01	4.5935259E-02	1.7528438E-04
2.8337016E-06	1.0434004E-04	9.5791802E-09	2.6743054E-11
7.2308217E-11	2.1825556E-12	1.3461301E-14	4.5698185E-17
3.2796417E-14	9.3941224E-14	3.0513507E-16	2.4499451E-18
8.2078351E-30	1.8048514E-35	4.2001731E-18	2.4594682E-19
1.0575672E-30	8.4923573E-22	4.6668607E-21	1.0666211E-23
6.6402430E-26	9.0986687E-26	1.2629677E-28	1.3671659E-29
4.3213531E-34	1.8048514E-35	1.8048514E-35	1.8048514E-35
8.4869499E-07	1.5290319E-03	1.3374696E-04	1.3639121E-04
1.3731530E-08			

TEMPERATURE = 8000.0000 PRESSURE = 500.00000 MOLES OF GAS =

4.0499338E-03	8.5641319E-01	1.3854170E-01	5.0402534E-04
1.9006443E-05	6.7516257E-05	1.3695479E-06	8.3090283E-09
2.4589167E-08	1.6582076E-09	3.6772096E-11	3.5898770E-13
1.1707802E-11	1.8446852E-10	2.5088643E-12	4.8008883E-14
1.9646389E-23	4.1871873E-31	1.3029505E-14	3.6445675E-15
5.7908036E-24	6.8448440E-18	5.1872885E-16	4.0821672E-18
3.8281431E-21	7.5198702E-20	2.3656939E-22	2.9285765E-24
1.8909735E-26	4.4429486E-29	1.1044075E-30	3.8878649E-29
2.3587800E-07	1.4468080E-04	2.7906733E-05	2.5154440E-05
5.1003829E-08			

TEMPERATURE = 6500.0000 PRESSURE = 500.00000 MOLES OF GAS =

2.6242351E-03	6.2766408E-01	3.6758991E-01	8.8043387E-04
6.7613103E-05	8.3912421E-04	9.4110647E-05	9.2230260E-07
3.1332358E-06	3.9729125E-07	2.6460116E-08	6.3411756E-10
1.4054067E-09	1.1397195E-07	4.8108668E-09	1.8132029E-10
3.1847999E-18	1.0130416E-24	1.1630648E-11	1.1198840E-11
2.1249197E-18	2.1839369E-14	8.1215239E-12	1.9359051E-13
8.8707192E-17	5.9509691E-15	3.6399890E-17	2.3165493E-19
4.0903369E-20	1.8824199E-22	2.1058109E-24	3.8914862E-22
3.4421134E-08	7.4793646E-06	3.9383771E-06	2.4324811E-06
8.4697082E-08			

C/H Mass Ratio = 0.05

0.95699 MOLES OF SOLID = 0.

1.3000101E-06	1.0508523E-07	2.6135981E-10
1.5824465E-13	2.7960446E-18	1.2248336E-09
9.5162663E-17	2.5196061E-21	3.1813309E-26
2.5400168E-20	5.1548455E-23	6.9179392E-26
3.4171873E-20	4.6331313E-22	1.5419958E-23
1.2424711E-25	2.8289163E-28	6.9137623E-35
2.9677096E-30	1.3197595E-32	1.3702972E-33
1.8048514E-35	1.5484317E-03	1.8525565E-06
1.1155895E-05	4.6037904E-06	5.7010962E-09

0.87786 MOLES OF SOLID = 0.

1.3527115E-05	4.9306171E-06	4.3226519E-08
1.3904421E-10	2.0907670E-14	1.1649007E-07
1.7439056E-12	1.4080234E-16	1.0220271E-20
1.4262133E-15	7.4065309E-18	2.7808799E-20
1.3114669E-15	6.0837981E-17	5.1858143E-18
1.2006638E-19	7.4491740E-22	3.8760664E-27
1.7970109E-23	2.6968982E-25	2.2426694E-27
5.0796371E-31	1.6413941E-04	8.5261283E-06
1.1096344E-05	2.8106411E-06	6.9745207E-08

0.72938 MOLES OF SOLID = 0.

7.5979238E-05	1.1484234E-04	3.3083693E-06
5.0242546E-08	3.1399306E-11	4.6272647E-06
5.6993485E-09	1.1126180E-12	3.0611849E-16
1.2569614E-11	1.1494362E-13	1.0933390E-15
7.6117656E-12	1.0581479E-12	2.1365203E-13
1.1334630E-14	1.5567884E-16	1.0977153E-20
7.3612486E-18	3.2718842E-19	1.3861912E-21
1.5100496E-23	1.4602966E-05	8.5510272E-07
6.6803440E-06	8.0473169E-07	4.0842929E-07

C/H Mass Ratio = 0.05

TEMPERATURE = 5000.0000 PRESSURE = 500.00000 MOLES OF GAS =

2.2830439E-04	2.4675896E-01	7.4887536E-01	2.3550195E-04
1.5339797E-05	1.8119440E-03	1.0558155E-03	1.3006684E-05
2.3602006E-05	5.5561282E-06	1.2677262E-06	8.3129460E-08
2.5725119E-09	1.9239661E-06	3.0082577E-07	2.1145020E-08
1.7118233E-14	9.3551495E-20	9.2695804E-11	4.1752256E-10
1.6617388E-14	2.7258434E-13	6.7587650E-10	6.0427907E-11
4.8899546E-15	1.1186826E-12	1.3489660E-14	1.6856414E-17
4.4652850E-17	4.1040246E-19	8.5286653E-22	8.4868162E-19

TEMPERATURE = 4000.0000 PRESSURE = 500.00000 MOLES OF GAS =

8.0594999E-06	6.8060567E-02	9.2690772E-01	2.0659456E-05
7.4914733E-07	7.8852748E-04	2.1398785E-03	2.4261333E-05
1.9461677E-05	7.2418094E-06	4.4835414E-06	6.8055062E-07
2.9231521E-10	1.9224483E-06	9.4771351E-07	9.8764510E-08
1.4447747E-12	6.1916824E-17	2.6140031E-11	4.9636983E-10
1.7533735E-12	6.1813611E-14	9.5804702E-10	2.7589227E-10
2.7857219E-15	1.9317612E-12	3.9498431E-14	6.5199293E-18
1.3165446E-16	2.0799643E-18	5.3504341E-22	2.6696269E-18

TEMPERATURE = 3000.0000 PRESSURE = 500.00000 MOLES OF GAS =

1.5239994E-08	6.9587696E-03	9.8630089E-01	1.4907937E-07
1.1883042E-09	4.4145411E-05	1.3679110E-03	1.1103325E-05
1.5171632E-06	1.1503184E-06	3.0367017E-06	1.6847453E-06
4.6449938E-13	1.0518457E-07	3.1122182E-07	5.4126436E-08
5.8996790E-11	3.2015004E-14	9.6314083E-14	1.8408137E-11
6.5014650E-11	7.7529744E-17	2.4219734E-11	4.3595646E-11
8.1633809E-18	3.4562868E-14	1.6277005E-15	5.0433494E-21
1.4901042E-18	5.3410409E-20	2.3470643E-25	1.7154085E-20

C/H Mass Ratio = 0.05

```
0.56850     MOLES OF SOLID =  0.
     8.3690722E-05    7.7863576E-04    9.8737516E-05
     3.2338842E-06    7.7211286E-09    7.6801934E-06
     1.2909754E-06    6.6297362E-10    6.4519311E-13
     3.6673084E-09    5.2111340E-11    1.4407989E-12
     5.0453223E-10    2.4154934E-10    1.2821990E-10
     6.6473898E-12    2.1014201E-13    3.8543839E-16
     3.2687206E-15    5.2627217E-16    5.0037417E-19
     1.1987525E-19
```

```
0.51496     MOLES OF SOLID =  0.
     2.5939030E-05    1.3075874E-03    6.4064171E-04
     2.4332028E-05    1.5000372E-07    1.4764462E-06
     1.4887448E-05    1.6934211E-08    3.9176463E-11
     3.6008283E-08    6.4369357E-10    4.3808910E-11
     9.0361273E-10    1.1790334E-09    1.3881132E-09
     4.5428094E-11    2.7577743E-12    1.0427541E-13
     7.2117994E-15    3.6053616E-15    5.5137908E-19
     1.1763045E-18
```

```
0.49724     MOLES OF SOLID =  0.
     1.3542010E-06    9.9310039E-04    4.1504650E-03
     1.0290212E-04    2.5056075E-06    1.0318292E-08
     5.9051051E-05    2.2741821E-07    1.8127011E-09
     6.1534742E-08    1.4665278E-09    4.0045379E-10
     6.3630807E-11    3.5555662E-10    1.4266020E-09
     1.2215856E-11    1.9882475E-12    9.4551154E-12
     9.8755299E-17    2.9082599E-16    1.2289315E-21
     4.4837040E-20
```

C/H Mass Ratio = 0.05

TEMPERATURE = 2200.0000 PRESSURE = 500.00000 MOLES OF GAS =

2.4292657E-13	2.4929781E-04	9.9132696E-01	1.5481017E-11
2.0851909E-15	1.2723978E-08	1.5194822E-05	6.9780434E-08
1.1402964E-10	2.6266703E-10	5.1062936E-09	1.8994831E-08
1.7567281E-20	7.1771168E-13	2.8544762E-11	1.0093620E-11
6.3731375E-12	6.2973337E-14	1.8703974E-21	1.0734502E-17
8.9238497E-13	4.6186827E-26	1.2257847E-18	3.1472683E-17
2.4987155E-27	1.5996213E-22	2.7252479E-23	3.3258457E-32
8.0902270E-29	1.1204260E-29	1.8048514E-35	6.1854264E-32

TEMPERATURE = 1600.0000 PRESSURE = 500.00000 MOLES OF GAS =

1.5807606E-20	2.4181603E-06	9.9153451E-01	1.3592964E-17
2.1373739E-24	1.2530263E-14	3.8541220E-09	7.6902614E-12
8.9739919E-18	1.1058181E-16	3.3442854E-14	1.9137317E-12
1.0981332E-32	7.4057494E-22	1.1797951E-18	1.1327059E-18
7.3710666E-15	2.2128262E-15	1.7244274E-34	1.3126701E-28
1.9226612E-17	1.8048514E-35	1.8518756E-31	2.0452109E-28
1.8048514E-35	1.8048514E-35	1.8048514E-35	1.8048514E-35
1.8048514E-35	1.8048514E-35	1.8048514E-35	1.8048514E-35

C/H Mass Ratio = 0.05

```
0.49384     MOLES OF SOLID =  0.
     2.4882528E-09    8.7515600E-05    8.3002352E-03
     1.6753224E-05    3.1101632E-06    2.0548933E-14
     1.3546458E-06    3.1101085E-08    1.5507350E-09
     6.1323309E-11    2.2997611E-12    4.7261873E-12
     1.0296580E-16    4.2383773E-15    1.0325664E-13
     1.8596866E-17    1.2977778E-17    7.1967292E-14
     4.6726004E-26    1.8066904E-24    5.6486744E-33
     2.1417013E-30
```

```
0.49373     MOLES OF SOLID =  0.
     1.2894728E-13    1.0696983E-06    8.4612625E-03
     1.8858519E-07    6.8922020E-07    8.3632188E-24
     3.9796800E-10    1.1772014E-10    8.6582302E-11
     7.7599794E-17    6.0227391E-18    2.1574893E-16
     6.0208393E-27    3.8228528E-24    1.2544088E-21
     3.5062670E-28    2.0226109E-27    2.5594747E-19
     1.8048514E-35    1.8048514E-35    1.8048514E-35
     1.8048514E-35
```

C/H Mass Ratio = 0.05

```
TEMPERATURE =10000.0000     PRESSURE =1000.00000     MOLES OF GAS =
    3.5629634E-03    9.0860372E-01    8.4670700E-02    3.0216701E-04
    4.5685124E-06    3.2298340E-04    5.6933254E-08    3.0518075E-10
    4.0192242E-10    2.3293162E-11    2.7584075E-13    1.7979567E-15
    1.7048955E-13    9.3763984E-13    5.8476387E-15    9.0147359E-17
    7.8807545E-27    2.2943300E-35    3.9207029E-17    4.4080469E-18
    4.9460180E-28    1.4234771E-20    1.5019495E-19    6.5909666E-22
    1.9986266E-24    5.2581576E-24    1.4013318E-26    7.3891411E-28
    8.0524204E-32    1.6005469E-34    3.4504042E-35    4.7073361E-35
    1.0660919E-06    1.0491737E-03    1.7964291E-04    1.7969074E-04
    3.0973282E-08
```

```
TEMPERATURE = 8000.0000     PRESSURE =1000.00000     MOLES OF GAS =
    3.7211381E-03    7.7053108E-01    2.2429735E-01    8.3333008E-04
    3.2091246E-05    2.0513082E-04    7.4874960E-06    8.1742218E-08
    1.3728535E-07    1.6659277E-08    6.6477152E-10    1.1678054E-11
    6.6753932E-11    1.8926073E-09    4.6318263E-11    1.5949000E-12
    1.2313412E-20    8.4975040E-28    1.3651718E-13    6.8713515E-14
    2.0597714E-21    1.3178950E-16    1.7971922E-14    2.5449635E-16
    1.3544509E-19    4.7876490E-18    2.7102363E-20    1.9040989E-22
    4.0654916E-24    1.7188405E-26    2.4248113E-28    1.5360177E-26
    3.0728060E-07    9.1811672E-05    3.5598821E-05    2.8723573E-05
    1.2209792E-07
```

```
TEMPERATURE = 6500.0000     PRESSURE =1000.00000     MOLES OF GAS =
    1.7520048E-03    5.0996197E-01    4.8530484E-01    9.5514611E-04
    6.0273440E-05    1.2155194E-03    2.2152100E-04    3.5276875E-06
    6.0602595E-06    1.2486698E-06    1.3513597E-07    5.2624681E-09
    2.2336867E-09    2.9434636E-07    2.0189457E-08    1.2364831E-09
    2.4605171E-16    2.0665812E-22    2.4682356E-11    3.8618574E-11
    8.3017234E-17    6.1884996E-14    3.7395832E-11    1.4484727E-12
    3.3563450E-16    3.6587762E-14    3.6365438E-16    1.1703398E-18
    4.4836571E-19    3.3529741E-21    1.8967704E-23    5.6957520E-21
    3.6152405E-08    3.8627426E-06    5.0339317E-06    2.0413667E-06
    1.1877993E-07
```

C/H Mass Ratio = 0.05

0.92183 MOLES OF SOLID = 0.

4.3028786E-06	6.6782466E-07	3.1891000E-09
3.4672385E-12	2.2584767E-16	3.5458733E-09
7.1887754E-15	3.6545142E-19	1.7010731E-23
1.7944928E-18	6.9924447E-21	1.8017677E-23
1.1759332E-18	3.0612341E-20	1.9562034E-21
1.4741222E-23	6.4443063E-26	5.8061336E-32
3.0796545E-28	2.6295685E-30	1.3298816E-31
1.8048514E-35	1.0832027E-03	1.1888285E-06
2.8219687E-05	5.6724637E-06	2.5895934E-08

0.81585 MOLES OF SOLID = 0.

4.0244512E-05	2.6396088E-05	4.1641405E-07
2.4614206E-09	1.1984287E-12	3.6143693E-07
1.0208234E-10	1.4831118E-14	3.4857838E-18
8.5257602E-14	7.9671011E-16	5.3827521E-18
4.4492855E-14	3.7140231E-15	5.6966981E-16
1.3469412E-17	1.5037388E-19	2.5335474E-24
2.1024229E-21	5.6776786E-23	2.6795166E-25
3.6112272E-28	1.1635973E-04	5.5253519E-06
2.2800299E-05	3.2775570E-06	2.6334970E-07

0.67078 MOLES OF SOLID = 0.

1.3393946E-04	3.2896988E-04	1.5399571E-05
3.1226896E-07	5.1529775E-10	5.5078485E-06
7.6857367E-08	2.4380727E-11	1.7712130E-14
1.3928495E-10	2.0697016E-12	3.1990282E-14
4.2652960E-11	9.6349782E-12	3.1611993E-12
1.3780793E-13	3.0756480E-15	5.7263506E-19
6.0431352E-17	4.3646493E-18	9.3509569E-21
3.5914298E-22	1.1486574E-05	3.6288694E-07
9.1098434E-06	5.5493829E-07	7.4368923E-07

C/H Mass Ratio = 0.05

TEMPERATURE = 5000.0000 PRESSURE =1000.00000 MOLES OF GAS =

1.1985326E-04	1.8184514E-01	8.1338674E-01	1.8221701E-04
8.4551406E-06	1.4719899E-03	1.2641739E-03	2.2953247E-05
2.0131428E-05	6.9848433E-06	2.3489220E-06	2.2701620E-07
1.5631111E-09	1.7230136E-06	3.9706825E-07	4.1135508E-08
2.3161212E-13	2.7496039E-18	5.9136842E-11	3.9253775E-10
1.0867094E-13	1.8258478E-13	6.6725196E-10	8.7926319E-11
3.4390152E-15	1.1595647E-12	2.0608585E-14	1.2446862E-17
5.1023273E-17	6.9117551E-19	6.9423607E-22	1.0181917E-18

TEMPERATURE = 4000.0000 PRESSURE =1000.00000 MOLES OF GAS =

3.7648599E-06	4.8613592E-02	9.4578135E-01	1.3786427E-05
3.2694794E-07	4.9160967E-04	1.9058328E-03	3.0867572E-05
1.1335858E-05	6.0257834E-06	5.3294147E-06	1.1556094E-06
1.1135357E-10	1.0461634E-06	7.3673999E-07	1.0968064E-07
9.5453081E-12	8.3479971E-16	9.3031405E-12	2.5236038E-10
5.3033561E-12	2.0553137E-14	4.5506471E-10	1.8720514E-10
8.6537092E-16	8.5725551E-13	2.5039670E-14	1.8922494E-18
5.0995789E-17	1.1509231E-18	1.3553959E-22	9.6609504E-19

TEMPERATURE = 3000.0000 PRESSURE =1000.00000 MOLES OF GAS =

5.2480980E-09	4.9236881E-03	9.8754197E-01	7.2647880E-08
2.8183311E-10	1.4816250E-05	6.4967853E-04	7.4624547E-06
3.5069667E-07	3.7627507E-07	1.4056518E-06	1.1035653E-06
5.2256903E-14	1.6745543E-08	7.0114152E-08	1.7255713E-08
1.0673130E-10	1.1598268E-13	7.4626999E-15	2.0183852E-12
4.0452604E-11	4.1373394E-18	1.8289853E-12	4.6587734E-12
3.0003473E-19	1.7976241E-15	1.1979846E-16	1.2766337E-22
3.6761987E-20	1.9344688E-21	2.8181723E-27	2.9147344E-22

C/H Mass Ratio = 0.05

```
0.54774     MOLES OF SOLID =  0.
     9.5440005E-05    1.3087186E-03    2.4459801E-04
     8.4112537E-06    4.3624918E-08    4.4446645E-06
     5.1961119E-06    3.9329254E-09    8.3143225E-12
     1.0515139E-08    2.2022077E-10    8.9740491E-12
     6.9920520E-10    4.9337850E-10    3.8600119E-10
     1.4255785E-11    6.6421964E-13    2.6464949E-15
     3.5573887E-15    8.4415649E-16    3.8793198E-19
     2.1196937E-19
```

```
0.50927     MOLES OF SOLID =  0.
     2.4727414E-05    1.7806876E-03    1.2463052E-03
     4.4224020E-05    5.5637304E-07    6.0200436E-07
     3.6112936E-05    5.8681314E-08    2.7704117E-10
     5.7124683E-08    1.4587896E-09    1.4182998E-10
     6.5628163E-10    1.2232801E-09    2.0573919E-09
     4.4034660E-11    3.8197532E-12    2.9466488E-13
     2.9900017E-15    2.1353463E-15    1.4950527E-19
     6.0810860E-19
```

```
0.49596     MOLES OF SOLID =  0.
     9.3384856E-07    9.6911334E-04    5.7314731E-03
     9.7868071E-05    4.7720599E-06    1.6854626E-09
     5.4736780E-05    2.9830807E-07    4.7614822E-09
     2.7760783E-08    9.3624490E-10    3.6177598E-10
     9.8730125E-12    7.8069157E-11    4.4326268E-10
     1.8473144E-12    4.2547632E-13    4.0517989E-12
     3.5375042E-18    1.4742047E-17    2.1425056E-23
     1.0780914E-21
```

C/H Mass Ratio = 0.05

TEMPERATURE = 2200.0000 PRESSURE =1000.00000 MOLES OF GAS =

6.1220519E-14	1.7628471E-04	9.9137778E-01	5.5175662E-12
2.6486220E-16	2.2857195E-09	3.8603060E-06	2.5071814E-08
1.0324512E-11	3.3634366E-11	9.2471890E-10	4.8648075E-09
5.6686841E-22	3.2753251E-14	1.8422845E-12	9.2130431E-13
3.2910936E-12	6.5042241E-14	3.0420262E-23	2.4690966E-19
1.1612844E-13	3.7861636E-28	1.4210905E-20	5.1602024E-19
1.0324073E-29	9.3470997E-25	2.2521182E-25	6.9260965E-35
1.2009496E-31	2.3521783E-32	1.8048514E-35	4.6279119E-35

TEMPERATURE = 1600.0000 PRESSURE =1000.00000 MOLES OF GAS =

3.9521369E-21	1.7098981E-06	9.9153498E-01	4.8061237E-18
2.6720372E-25	2.2153241E-15	9.6364629E-10	2.7192467E-12
7.9334099E-19	1.3825224E-17	5.9129870E-15	4.7851917E-13
3.4324829E-34	3.2736863E-23	7.3754917E-20	1.0014199E-19
3.6864244E-15	2.2133581E-15	1.8048514E-35	2.9014824E-30
2.4040475E-18	1.8048514E-35	2.0467822E-33	3.1968033E-30
1.8048514E-35	1.8048514E-35	1.8048514E-35	1.8048514E-35
1.8048514E-35	1.8048514E-35	1.8048514E-35	1.8048514E-35

C/H. Mass Ratio = 0.05

```
0.49380     MOLES OF SOLID =  0.
     1.2542056E-09    6.2385806E-05    8.3679074E-03
     8.5128849E-06    3.1609222E-06    1.3155726E-15
     4.9066115E-07    1.5931539E-08    1.5888110E-09
     7.9160331E-12    4.1984736E-13    1.2202390E-12
     3.3494620E-18    1.9498821E-16    6.7181885E-15
     4.3122014E-19    4.2558460E-19    4.7203400E-15
     1.3761625E-28    7.5252671E-27    1.8048514E-35
     2.2662210E-33
```

```
0.49373     MOLES OF SOLID =  0.
     6.4477528E-14    7.5643675E-07    8.4617761E-03
     9.4303970E-08    6.8930367E-07    5.2279390E-25
     1.4072860E-10    5.8870712E-11    8.6598034E-11
     9.7022920E-18    1.0649386E-18    5.3950299E-17
     1.8820785E-28    1.6899822E-25    7.8424028E-23
     7.7506536E-30    6.3229591E-29    1.6002515E-20
     1.8048514E-35    1.8048514E-35    1.8048514E-35
     1.8048514E-35
```

APPENDIX D

OPTICAL CONSTANTS OF THE CARBON-HYDROGEN MIXTURES

Presented here are the results for the optical constants of carbon-hydrogen mixtures with C/H mass ratios of 0.005, 0.01, and 0.05, gas pressures of 100, 500, and 1000 atm., and gas temperatures of 1600, 2200, 3000, 4000, 5000, 6500, 8000, and 10,000°K. The arrangement of these 72 cases is given in the index below, and the computer print-out is arranged so that the cases are in numerical order by case number. This print-out consists of one page for each case, giving the total spectral absorption coefficients for the gas mixtures, and the Planck and Rosseland mean absorption coefficients, as well as other data not specifically requested in this contract.

The results are arranged in the following way, with floating point notation used throughout:

The case number is given at the top of each page, to the right of the equilibrium temperature of the gas mixture ("TEMPERATURE") (°K), the C/H mass ratio, and the total gas pressure ("PRESSURE") (atm.). Below this are the mid-points of the spectral-averaging intervals* ("OMEGA") (cm^{-1}) and the averaged spectral absorption coefficients (cm^{-1}) summed over all molecular band systems and all absorption processes considered ("TOTAL MU") (cm^{-1}), the Planck spectral intensity function, ("B(W, T)") ($erg\text{-}sec^{-1}\text{-}cm^{-2}\text{-}ster^{-1}\text{-}(cm^{-1}(\Delta\omega))^{-1}$), and the spectral volume emission coefficient ("J") ($erg\text{-}sec^{-1}\text{-}cm^{-3}\text{-}ster^{-1}\text{-}(cm^{-1}\text{-}(cm^{-1}(\Delta\omega))^{-1}$), which is equal to the product of the "TOTAL MU" and "B(W, T)" columns for each "OMEGA" value. The quantities printed-out from the integration of the total spectral absorption coefficients are:

- $J'(T)$ ("J TOTAL") ($erg\text{-}sec^{-1}\text{-}cm^{-3}\text{-}ster^{-1}$)
- μ_P ("PLANCK MEAN OPACITY") (cm^{-1})
- $\mu_P^{(2)}$ ("MEAN-SQUARED PLANCK MEAN OPACITY") (cm^{-2})
- Λ_R ("ROSSELAND MEAN-FREE-PATH") (cm)
- $\Lambda_2^{(2)}$ ("MEAN-SQUARED ROSSELAND MEAN-FREE-PATH") (cm^2)
- μ_R ("1/ROSSELAND MEAN-FREE-PATH") (cm^{-1})
- I' ("I PRIME") (cm^2)

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* For a listing of the correspondence of these "OMEGA" values with the dimensionless frequency interval mid-points specified in the contract, please see the table below.

INDEX OF OPACITY CASES

Case No's.	Gas Temperature (°K)	Gas Pressure (atm)	Respective C/H Mass Ratio
1, 2, 3	1600	100	0.005, 0.01, 0.05
4, 5, 6	1600	500	"
7, 8, 9	1600	1000	"
10, 11, 12	2200	100	"
13, 14, 15	2200	500	"
16, 17, 18	2200	1000	"
19, 20, 21	3000	100	"
22, 23, 24	3000	500	"
25, 26, 27	3000	1000	"
28, 29, 30	4000	100	"
31, 32, 33	4000	500	"
34, 35, 36	4000	1000	"
37, 38, 39	5000	100	"
40, 41, 42	5000	500	"
43, 44, 45	5000	1000	"
46, 47, 48	6500	100	"
49, 50, 51	6500	500	"
52, 53, 54	6500	1000	"
55, 56, 57	8000	100	"
58, 59, 60	8000	500	"
61, 62, 63	8000	1000	"
64, 65, 66	10,000	100	"
67, 68, 69	10,000	500	"
70, 71, 72	10,000	1000	"

Correspondence Table of Optical Frequencies

The present computer calculations of the optical constants were to be done for a spectral range defined by a dimensionless frequency, $u = hc\,\omega/5000k = 2.00$ to 19.50, in steps of $\Delta u = 0.50$, where hc/k is the second radiation constant, equal to 1.43879 cm-°K. The OPSAB computer program will only consider spectral ranges of ω, wavenumber (cm^{-1}), and thus we give here a correspondence table for ω and u to aid in interpreting the OPSAB print-out, which gives only the center points of the ω-intervals considered.

Using the value for hc/k, we find

$$\omega = (3.47514 \times 10^3)\, u$$

and

$$\Delta\omega \doteq (3.47514 \times 10^3)\, \Delta u.$$

The intervals of $\Delta u = 0.50$ corresponds to intervals of $\Delta\omega = 1737.57$ cm^{-1}. The calculations of the OPSAB program were carried out for the spectral range $\omega = 6950.28$ cm^{-1} ($u = 2.00$) to $\omega = 69502.80$ cm^{-1} ($u = 2.00$) to 67765.23 cm^{-1} ($u = 19.50$), with the center-point of each averaging interval of width $\Delta\omega$ (as above) printed in the left-most column ("OMEGA"). These center-points correspond to the points $u = 2.25$ to 19.25 in steps of $\Delta u = 0.50$. We give here the correspondence of the mid-points for the ω- and the u-variables.

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*This includes one additional spectral averaging interval at the large frequence end of the spectral range considered. This was added to improve the accuracy of the calculations for band systems of diatomic molecules at this end of the spectrum.

u	$\omega(cm^{-1})$	u	$\omega(cm^{-1})$
2.25	7819.06	11.25	39095.3
2.75	9556.63	11.75	40832.9
3.25	11294.2	12.25	42570.5
3.75	13031.8	12.75	44308.0
4.25	14769.3	13.25	46045.6
4.75	16506.9	13.75	47783.2
5.25	18244.5	14.25	49520.7
5.75	19982.1	14.75	51258.3
6.25	21719.6	15.25	52995.9
6.75	23457.2	15.75	54733.5
7.25	25194.8	16.25	56471.0
7.75	26932.3	16.75	58208.6
8.25	28669.9	17.25	59946.2
8.75	30407.5	17.75	61683.7
9.25	32145.0	18.25	63421.3
9.75	33882.6	18.75	65158.9
10.25	35620.2	19.25	66896.4
10.75	37357.8		

TEMPERATURE = 1.60000E+03 C/H MASS RATIO = 5.00000E-03 PRESSURE = 1.00000E+02

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	1.49911E-13	5.03636E+03	7.55008E-10
9.55663E+03	1.90790E-12	1.92611E+03	3.67482E-09
1.12942E+04	6.53509E-12	6.66323E+02	4.35508E-09
1.30318E+04	5.75109E-12	2.14551E+02	1.23390E-09
1.47693E+04	1.29785E-12	6.54662E+01	8.49656E-11
1.65069E+04	7.61282E-14	1.91578E+01	1.45845E-12
1.82445E+04	3.43259E-15	5.42200E+00	1.86115E-14
1.99821E+04	8.70306E-15	1.49314E+00	1.29949E-14
2.17196E+04	2.75054E-14	4.01933E-01	1.10553E-14
2.34572E+04	6.63770E-14	1.06131E-01	7.04463E-15
2.51948E+04	1.06023E-13	2.75651E-02	2.92254E-15
2.69323E+04	1.25893E-13	7.05776E-03	8.88521E-16
2.86699E+04	1.08312E-13	1.78459E-03	1.93293E-16
3.04075E+04	6.68911E-14	4.46291E-04	2.98529E-17
3.21450E+04	3.14231E-14	1.10518E-04	3.47284E-18
3.38826E+04	1.12109E-14	2.71293E-05	3.04144E-19
3.56202E+04	6.00280E-13	6.60713E-06	3.96613E-18
3.73578E+04	8.42804E-11	1.59765E-06	1.34651E-16
3.90953E+04	2.01705E-08	3.83823E-07	7.74191E-15
4.08329E+04	2.80657E-06	9.16649E-08	2.57264E-13
4.25705E+04	1.05602E-04	2.17728E-08	2.29924E-12
4.43080E+04	1.02012E-03	5.14579E-09	5.24934E-12
4.60456E+04	2.52470E-03	1.21056E-09	3.05629E-12
4.77832E+04	1.60069E-03	2.83571E-10	4.53909E-13
4.95207E+04	2.59982E-04	6.61628E-11	1.72011E-14
5.12583E+04	1.08236E-05	1.53802E-11	1.66469E-16
5.29959E+04	2.72890E-07	3.56296E-12	9.72296E-19
5.47335E+04	2.16565E-06	8.22733E-13	1.78175E-18
5.64710E+04	1.64087E-05	1.89406E-13	3.10790E-18
5.82086E+04	6.82461E-05	4.34804E-14	2.96737E-18
5.99462E+04	1.56209E-04	9.95480E-15	1.55503E-18
6.16837E+04	2.16680E-04	2.27340E-15	4.92601E-19
6.34213E+04	6.22487E-04	5.17948E-16	3.22416E-19
6.51589E+04	3.14137E-03	1.17738E-16	3.69859E-19
6.68964E+04	5.10524E-03	2.67068E-17	1.36345E-19

J TOTAL = 1.75784E-05

PLANCK MEAN OPACITY = 1.27487E-12 MEAN-SQUARED PLANCK MEAN OPACITY = 1.77001E-18
ROSSELAND MEAN-FREE-PATH = 4.48054E+12 1/ROSSELAND MEAN-FREE-PATH = 2.23187E-13
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 1.52591E+26 I PRIME = 3.21769E+26

TEMPERATURE = 1.60000E+03 C/H MASS RATIO = 1.00000E-02 PRESSURE = 1.00000E+02

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	5.85559E-13	5.03636E+03	2.94909E-09
9.55663E+03	7.64997E-12	1.92611E+03	1.47347E-08
1.12942E+04	2.62458E-11	6.66323E+02	1.74882E-08
1.30318E+04	2.30965E-11	2.14551E+02	4.95538E-09
1.47693E+04	5.20971E-12	6.54662E+01	3.41060E-10
1.65069E+04	3.03234E-13	1.91578E+01	5.80932E-12
1.82445E+04	9.10699E-15	5.42200E+00	4.93781E-14
1.99821E+04	1.74448E-14	1.49314E+00	2.60475E-14
2.17196E+04	5.51062E-14	4.01933E-01	2.21490E-14
2.34572E+04	1.32986E-13	1.06131E-01	1.41139E-14
2.51948E+04	2.12415E-13	2.75651E-02	5.85523E-15
2.69323E+04	2.52252E-13	7.05776E-03	1.78012E-15
2.86699E+04	2.16999E-13	1.78459E-03	3.87256E-16
3.04075E+04	1.34015E-13	4.46291E-04	5.98098E-17
3.21450E+04	6.29690E-14	1.10518E-04	6.95924E-18
3.38826E+04	2.59563E-14	2.71293E-05	7.04179E-19
3.56202E+04	2.37700E-12	6.60713E-06	1.57051E-17
3.73578E+04	2.71873E-10	1.59765E-06	4.34359E-16
3.90953E+04	4.27179E-08	3.83823E-07	1.63961E-14
4.08329E+04	5.63479E-06	9.16649E-08	5.16513E-13
4.25705E+04	2.11536E-04	2.17728E-08	4.60572E-12
4.43080E+04	2.04327E-03	5.14579E-09	1.05143E-11
4.60456E+04	5.05688E-03	1.21056E-09	6.12163E-12
4.77832E+04	3.20612E-03	2.83571E-10	9.09161E-13
4.95207E+04	5.20734E-04	6.61628E-11	3.44532E-14
5.12583E+04	2.16920E-05	1.53802E-11	3.33626E-16
5.29959E+04	8.63207E-07	3.56296E-12	3.07557E-18
5.47335E+04	8.68140E-06	8.22733E-13	7.14248E-18
5.64710E+04	6.57216E-05	1.89406E-13	1.24481E-17
5.82086E+04	2.73404E-04	4.34804E-14	1.18877E-17
5.99462E+04	6.25990E-04	9.95480E-15	6.23161E-18
6.16837E+04	8.29536E-04	2.27340E-15	1.88587E-18
6.34213E+04	1.52200E-03	5.17948E-16	7.88318E-19
6.51589E+04	6.40178E-03	1.17738E-16	7.53734E-19
6.68964E+04	1.02505E-02	2.67068E-17	2.73999E-19

J TOTAL = 7.03664E-05

PLANCK MEAN OPACITY = 5.10332E-12 MEAN-SQUARED PLANCK MEAN OPACITY = 7.10114E-18
ROSSELAND MEAN-FREE-PATH = 1.20895E+12 1/ROSSELAND MEAN-FREE-PATH = 8.27164E-13
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 2.03040E+25 I PRIME = 4.56173E+25

TEMPERATURE = 1.60000E+03 C/H MASS RATIO = 5.00000E-02 PRESSURE = 1.00000E+02

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	1.48440E-11	5.03636E+03	7.47596E-08
9.55663E+03	1.98148E-10	1.92611E+03	3.81654E-07
1.12942E+04	6.80626E-10	6.66323E+02	4.53516E-07
1.30318E+04	5.99006E-10	2.14551E+02	1.28518E-07
1.47693E+04	1.35062E-10	6.54662E+01	8.84198E-09
1.65069E+04	7.81248E-12	1.91578E+01	1.49670E-10
1.82445E+04	1.39002E-13	5.42200E+00	7.53668E-13
1.99821E+04	8.87434E-14	1.49314E+00	1.32505E-13
2.17196E+04	2.79216E-13	4.01933E-01	1.12226E-13
2.34572E+04	6.73967E-13	1.06131E-01	7.15285E-14
2.51948E+04	1.07639E-12	2.75651E-02	2.96707E-14
2.69323E+04	1.27802E-12	7.05776E-03	9.01998E-15
2.86699E+04	1.09976E-12	1.78459E-03	1.96263E-15
3.04075E+04	6.80099E-13	4.46291E-04	3.03522E-16
3.21450E+04	3.22685E-13	1.10518E-04	3.56626E-17
3.38826E+04	2.83374E-13	2.71293E-05	7.68774E-18
3.56202E+04	6.07450E-11	6.60713E-06	4.01350E-16
3.73578E+04	5.64837E-09	1.59765E-06	9.02414E-15
3.90953E+04	3.11837E-07	3.83823E-07	1.19690E-13
4.08329E+04	2.90073E-05	9.16649E-08	2.65895E-12
4.25705E+04	1.06899E-03	2.17728E-08	2.32750E-11
4.43080E+04	1.03181E-02	5.14579E-09	5.30947E-11
4.60456E+04	2.55354E-02	1.21056E-09	3.09120E-11
4.77832E+04	1.61897E-02	2.83571E-10	4.59093E-12
4.95207E+04	2.62952E-03	6.61628E-11	1.73977E-13
5.12583E+04	1.10061E-04	1.53802E-11	1.69276E-15
5.29959E+04	1.74025E-05	3.56296E-12	6.20045E-17
5.47335E+04	2.23101E-04	8.22733E-13	1.83552E-16
5.64710E+04	1.69065E-03	1.89406E-13	3.20220E-16
5.82086E+04	7.03148E-03	4.34804E-14	3.05732E-16
5.99462E+04	1.60739E-02	9.95480E-15	1.60012E-16
6.16837E+04	2.04820E-02	2.27340E-15	4.65639E-17
6.34213E+04	1.90410E-02	5.17948E-16	9.86227E-18
6.51589E+04	3.72878E-02	1.17738E-16	4.39020E-18
6.68964E+04	5.39257E-02	2.67068E-17	1.44018E-18

J TOTAL = 1.82020E-03

PLANCK MEAN OPACITY = 1.32010E-10 MEAN-SQUARED PLANCK MEAN OPACITY = 1.81137E-16
ROSSELAND MEAN-FREE-PATH = 5.59893E+10 1/ROSSELAND MEAN-FREE-PATH = 1.78605E-11
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 1.32401E+23 I PRIME = 3.22408E+23

TEMPERATURE = 1.60000E+03 C/H MASS RATIO = 5.00000E-03 PRESSURE = 5.00000E+02

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	2.09453E-14	5.03636E+03	1.05488E-10
9.55663E+03	1.77193E-13	1.92611E+03	3.41292E-10
1.12942E+04	5.89392E-13	6.66323E+02	3.92725E-10
1.30318E+04	5.17480E-13	2.14551E+02	1.11026E-10
1.47693E+04	1.17911E-13	6.54662E+01	7.71921E-12
1.65069E+04	7.97966E-15	1.91578E+01	1.52873E-13
1.82445E+04	2.42462E-15	5.42200E+00	1.31463E-14
1.99821E+04	8.69968E-15	1.49314E+00	1.29899E-14
2.17196E+04	2.75096E-14	4.01933E-01	1.10570E-14
2.34572E+04	6.47634E-14	1.06131E-01	6.87338E-15
2.51948E+04	1.05675E-13	2.75651E-02	2.91295E-15
2.69323E+04	1.25891E-13	7.05776E-03	8.88509E-16
2.86699E+04	1.08213E-13	1.78459E-03	1.93116E-16
3.04075E+04	6.68353E-14	4.46291E-04	2.98280E-17
3.21450E+04	3.04494E-14	1.10518E-04	3.36522E-18
3.38826E+04	9.82162E-15	2.71293E-05	2.66454E-19
3.56202E+04	1.51854E-13	6.60713E-06	1.00332E-18
3.73578E+04	8.42347E-11	1.59765E-06	1.34578E-16
3.90953E+04	4.27512E-08	3.83823E-07	1.64089E-14
4.08329E+04	6.26092E-06	9.16649E-08	5.73906E-13
4.25705E+04	2.36065E-04	2.17728E-08	5.13979E-12
4.43080E+04	2.28020E-03	5.14579E-09	1.17355E-11
4.60456E+04	5.64426E-03	1.21056E-09	6.83270E-12
4.77832E+04	3.57863E-03	2.83571E-10	1.01477E-12
4.95207E+04	5.81220E-04	6.61628E-11	3.84551E-14
5.12583E+04	2.41896E-05	1.53802E-11	3.72040E-16
5.29959E+04	4.15240E-07	3.56296E-12	1.47948E-18
5.47335E+04	2.15942E-06	8.22733E-13	1.77663E-18
5.64710E+04	1.63137E-05	1.89406E-13	3.08991E-18
5.82086E+04	6.79015E-05	4.34804E-14	2.95239E-18
5.99462E+04	1.56179E-04	9.95480E-15	1.55473E-18
6.16837E+04	2.41306E-04	2.27340E-15	5.48586E-19
6.34213E+04	1.22367E-03	5.17948E-16	6.33795E-19
6.51589E+04	6.95101E-03	1.17738E-16	8.18399E-19
6.68964E+04	1.14188E-02	2.67068E-17	3.04960E-19

J TOTAL = 1.70943E-06

PLANCK MEAN OPACITY = 1.23976E-13 MEAN-SQUARED PLANCK MEAN OPACITY = 8.84641E-18
ROSSELAND MEAN-FREE-PATH = 3.01315E+13 1/ROSSELAND MEAN-FREE-PATH = 3.31879E-14
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 1.62036E+27 I PRIME = 1.80976E+27

TOTAL OPACITIES AND VOLUME EMISSION

TEMPERATURE = 1.60000E+03 C/H MASS RATIO = 1.00000E-02 PRESSURE = 5.00000E+02

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	6.75077E-14	5.03636E+03	3.39994E-10
9.55663E+03	6.97834E-13	1.92611E+03	1.34410E-09
1.12942E+04	2.35879E-12	6.66323E+02	1.57171E-09
1.30318E+04	2.07348E-12	2.14551E+02	4.44867E-10
1.47693E+04	4.69966E-13	6.54662E+01	3.07669E-11
1.65069E+04	2.94861E-14	1.91578E+01	5.64891E-13
1.82445E+04	5.05664E-15	5.42200E+00	2.74171E-14
1.99821E+04	1.74275E-14	1.49314E+00	2.60218E-14
2.17196E+04	5.51058E-14	4.01933E-01	2.21489E-14
2.34572E+04	1.29734E-13	1.06131E-01	1.37687E-14
2.51948E+04	2.11684E-13	2.75651E-02	5.83509E-15
2.69323E+04	2.52179E-13	7.05776E-03	1.77982E-15
2.86699E+04	2.16767E-13	1.78459E-03	3.86841E-16
3.04075E+04	1.33881E-13	4.46291E-04	5.97500E-17
3.21450E+04	6.09977E-14	1.10518E-04	6.74137E-18
3.38826E+04	2.03657E-14	2.71293E-05	5.52508E-19
3.56202E+04	5.41169E-13	6.60713E-06	3.57558E-18
3.73578E+04	1.94285E-10	1.59765E-06	3.10400E-16
3.90953E+04	8.89431E-08	3.83823E-07	3.41384E-14
4.08329E+04	1.29627E-05	9.16649E-08	1.18823E-12
4.25705E+04	4.88661E-04	2.17728E-08	1.06395E-11
4.43080E+04	4.72086E-03	5.14579E-09	2.42925E-11
4.60456E+04	1.16837E-02	1.21056E-09	1.41438E-11
4.77832E+04	7.40769E-03	2.83571E-10	2.10058E-12
4.95207E+04	1.20313E-03	6.61628E-11	7.96025E-14
5.12583E+04	5.00850E-05	1.53802E-11	7.70316E-16
5.29959E+04	1.16578E-06	3.56296E-12	4.15363E-18
5.47335E+04	8.66804E-06	8.22733E-13	7.13149E-18
5.64710E+04	6.54942E-05	1.89406E-13	1.24050E-17
5.82086E+04	2.72586E-04	4.34804E-14	1.18522E-17
5.99462E+04	6.25954E-04	9.95480E-15	6.23125E-18
6.16837E+04	8.81779E-04	2.27340E-15	2.00464E-18
6.34213E+04	2.79661E-03	5.17948E-16	1.44850E-18
6.51589E+04	1.44799E-02	1.17738E-16	1.70484E-18
6.68964E+04	2.36039E-02	2.67068E-17	6.30385E-19

J TOTAL = 6.57598E-06

PLANCK MEAN OPACITY = 4.76922E-13 MEAN-SQUARED PLANCK MEAN OPACITY = 3.79064E-17
ROSSELAND MEAN-FREE-PATH = 9.32878E+12 1/ROSSELAND MEAN-FREE-PATH = 1.07195E-13
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 1.87242E+26 I PRIME = 2.48801E+26

TEMPERATURE = 1.60000E+03 C/H MASS RATIO = 5.00000E-02 PRESSURE = 5.00000E+02

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	1.40525E-12	5.03636E+03	7.07738E-09
9.55663E+03	1.78038E-11	1.92611E+03	3.42920E-08
1.12942E+04	6.09753E-11	6.66323E+02	4.06292E-08
1.30318E+04	5.36518E-11	2.14551E+02	1.15111E-08
1.47693E+04	1.21087E-11	6.54662E+01	7.92710E-10
1.65069E+04	7.11219E-13	1.91578E+01	1.36254E-11
1.82445E+04	3.39336E-14	5.42200E+00	1.83988E-13
1.99821E+04	8.83337E-14	1.49314E+00	1.31895E-13
2.17196E+04	2.79212E-13	4.01933E-01	1.12224E-13
2.34572E+04	6.57383E-13	1.06131E-01	6.97685E-14
2.51948E+04	1.07258E-12	2.75651E-02	2.95657E-14
2.69323E+04	1.27775E-12	7.05776E-03	9.01802E-15
2.86699E+04	1.09833E-12	1.78459E-03	1.96007E-15
3.04075E+04	6.78368E-13	4.46291E-04	3.02749E-16
3.21450E+04	3.09175E-13	1.10518E-04	3.41696E-17
3.38826E+04	1.31939E-13	2.71293E-05	3.57942E-18
3.56202E+04	1.24746E-11	6.60713E-06	8.24217E-17
3.73578E+04	1.81182E-09	1.59765E-06	2.89467E-15
3.90953E+04	4.53947E-07	3.83823E-07	1.74235E-13
4.08329E+04	6.34443E-05	9.16649E-08	5.81561E-12
4.25705E+04	2.38763E-03	2.17728E-08	5.19854E-11
4.43080E+04	2.30650E-02	5.14579E-09	1.18687E-10
4.60456E+04	5.70834E-02	1.21056E-09	6.91027E-11
4.77832E+04	3.61916E-02	2.83571E-10	1.02629E-11
4.95207E+04	5.87879E-03	6.61628E-11	3.88918E-13
5.12583E+04	2.45220E-04	1.53802E-11	3.77153E-15
5.29959E+04	1.85777E-05	3.56296E-12	6.61915E-17
5.47335E+04	2.18947E-04	8.22733E-13	1.80135E-16
5.64710E+04	1.65467E-03	1.89406E-13	3.13385E-16
5.82086E+04	6.88612E-03	4.34804E-14	2.99412E-16
5.99462E+04	1.57952E-02	9.95480E-15	1.57208E-16
6.16837E+04	2.04045E-02	2.27340E-15	4.63877E-17
6.34213E+04	2.48739E-02	5.17948E-16	1.28834E-17
6.51589E+04	7.51216E-02	1.17738E-16	8.84468E-18
6.68964E+04	1.16942E-01	2.67068E-17	3.12314E-18

J TOTAL = 1.64327E-04

PLANCK MEAN OPACITY = 1.19178E-11 MEAN-SQUARED PLANCK MEAN OPACITY = 9.04848E-16
ROSSELAND MEAN-FREE-PATH = 4.75355E+11 1/ROSSELAND MEAN-FREE-PATH = 2.10369E-12
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 1.58834E+24 I PRIME = 3.31048E+24

TOTAL OPACITIES AND VOLUME EMISSION

TEMPERATURE = 1.60000E+03 C/H MASS RATIO = 5.00000E-03 PRESSURE = 1.00000E+03

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	1.27621E-14	5.03636E+03	6.42748E-11
9.55663E+03	6.73598E-14	1.92611E+03	1.29742E-10
1.12942E+04	2.12011E-13	6.66323E+02	1.41268E-10
1.30318E+04	1.85347E-13	2.14551E+02	3.97665E-11
1.47693E+04	4.30305E-14	6.54662E+01	2.81704E-12
1.65069E+04	3.65583E-15	1.91578E+01	7.00225E-14
1.82445E+04	2.36099E-15	5.42200E+00	1.28013E-14
1.99821E+04	8.70059E-15	1.49314E+00	1.29912E-14
2.17196E+04	2.75139E-14	4.01933E-01	1.10587E-14
2.34572E+04	6.43896E-14	1.06131E-01	6.83371E-15
2.51948E+04	1.05606E-13	2.75651E-02	2.91103E-15
2.69323E+04	1.25906E-13	7.05776E-03	8.88612E-16
2.86699E+04	1.08263E-13	1.78459E-03	1.93098E-16
3.04075E+04	6.68362E-14	4.46291E-04	2.98257E-17
3.21450E+04	3.02237E-14	1.10518E-04	3.34027E-18
3.38826E+04	9.65244E-15	2.71293E-05	2.61864E-19
3.56202E+04	1.07203E-13	6.60713E-06	7.08306E-19
3.73578E+04	1.09833E-10	1.59765E-06	1.75475E-16
3.90953E+04	6.02881E-08	3.83823E-07	2.31399E-14
4.08329E+04	8.85885E-06	9.16649E-08	8.12045E-13
4.25705E+04	3.34063E-04	2.17728E-08	7.27347E-12
4.43080E+04	3.22736E-03	5.14579E-09	1.66073E-11
4.60456E+04	7.98741E-03	1.21056E-09	9.66921E-12
4.77832E+04	5.06411E-03	2.83571E-10	1.43603E-12
4.95207E+04	8.22506E-04	6.61628E-11	5.44193E-14
5.12583E+04	3.42289E-05	1.53802E-11	5.26447E-16
5.29959E+04	5.22307E-07	3.56296E-12	1.86096E-18
5.47335E+04	2.15987E-06	8.22733E-13	1.77700E-18
5.64710E+04	1.63094E-05	1.89406E-13	3.08910E-18
5.82086E+04	6.78943E-05	4.34804E-14	2.95207E-18
5.99462E+04	1.56463E-04	9.95480E-15	1.55746E-18
6.16837E+04	2.60093E-04	2.27340E-15	5.91297E-19
6.34213E+04	1.67649E-03	5.17948E-16	8.68335E-19
6.51589E+04	9.82113E-03	1.17738E-16	1.15632E-18
6.68964E+04	1.61950E-02	2.67068E-17	4.32435E-19

J TOTAL = 7.19115E-07

PLANCK MEAN OPACITY = 5.21538E-14 MEAN-SQUARED PLANCK MEAN OPACITY = 1.77159E-17
ROSSELAND MEAN-FREE-PATH = 5.12710E+13 1/ROSSELAND MEAN-FREE-PATH = 1.95042E-14
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 4.14899E+27 I PRIME = 4.27696E+27

TEMPERATURE = 1.60000E+03 C/H MASS RATIO = 1.00000E-02 PRESSURE = 1.00000E+03

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	3.45948E-14	5.03636E+03	1.74232E-10
9.55663E+03	2.56149E-13	1.92611E+03	4.93370E-10
1.12942E+04	8.41190E-13	6.66323E+02	5.60504E-10
1.30318E+04	7.37840E-13	2.14551E+02	1.58305E-10
1.47693E+04	1.68839E-13	6.54662E+01	1.10533E-11
1.65069E+04	1.20943E-14	1.91578E+01	2.31701E-13
1.82445E+04	4.79930E-15	5.42200E+00	2.60218E-14
1.99821E+04	1.74261E-14	1.49314E+00	2.60196E-14
2.17196E+04	5.51058E-14	4.01933E-01	2.21488E-14
2.34572E+04	1.28963E-13	1.06131E-01	1.36869E-14
2.51948E+04	2.11511E-13	2.75651E-02	5.83032E-15
2.69323E+04	2.52168E-13	7.05776E-03	1.77974E-15
2.86699E+04	2.16712E-13	1.78459E-03	3.86743E-16
3.04075E+04	1.33850E-13	4.46291E-04	5.97360E-17
3.21450E+04	6.05342E-14	1.10518E-04	6.69014E-18
3.38826E+04	1.96773E-14	2.71293E-05	5.33832E-19
3.56202E+04	3.32173E-13	6.60713E-06	2.19471E-18
3.73578E+04	2.30161E-10	1.59765E-06	3.67718E-16
3.90953E+04	1.20905E-07	3.83823E-07	4.64061E-14
4.08329E+04	1.77332E-05	9.16649E-08	1.62552E-12
4.25705E+04	6.68663E-04	2.17728E-08	1.45586E-11
4.43080E+04	6.45989E-03	5.14579E-09	3.32412E-11
4.60456E+04	1.59876E-02	1.21056E-09	1.93539E-11
4.77832E+04	1.01363E-02	2.83571E-10	2.87437E-12
4.95207E+04	1.64633E-03	6.61628E-11	1.08926E-13
5.12583E+04	6.85265E-05	1.53802E-11	1.05394E-15
5.29959E+04	1.36237E-06	3.56296E-12	4.85406E-18
5.47335E+04	8.66647E-06	8.22733E-13	7.13019E-18
5.64710E+04	6.54557E-05	1.89406E-13	1.23977E-17
5.82086E+04	2.72455E-04	4.34804E-14	1.18465E-17
5.99462E+04	6.26283E-04	9.95480E-15	6.23452E-18
6.16837E+04	9.15891E-04	2.27340E-15	2.08219E-18
6.34213E+04	3.62585E-03	5.17948E-16	1.87800E-18
6.51589E+04	1.97394E-02	1.17738E-16	2.32408E-18
6.68964E+04	3.23094E-02	2.67068E-17	8.62879E-19

J TOTAL = 2.55354E-06

PLANCK MEAN OPACITY = 1.85195E-13 MEAN-SQUARED PLANCK MEAN OPACITY = 7.09775E-17
ROSSELAND MEAN-FREE-PATH = 1.83742E+13 1/ROSSELAND MEAN-FREE-PATH = 5.44241E-14
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 5.72388E+26 PRIME = 6.09851E+26

TEMPERATURE = 1.60000E+03 C/H MASS RATIO = 5.00000E-02 PRESSURE = 1.00000E+03

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	5.51103E-13	5.03636E+03	2.77601E-09
9.55663E+03	6.34214E-12	1.92611E+03	1.22156E-08
1.12942E+04	2.15939E-11	6.66323E+02	1.43885E-08
1.30318E+04	1.89921E-11	2.14551E+02	4.07479E-09
1.47693E+04	4.29449E-12	6.54662E+01	2.81144E-10
1.65069E+04	2.59907E-13	1.91578E+01	4.97925E-12
1.82445E+04	2.72633E-14	5.42200E+00	1.47822E-13
1.99821E+04	8.83336E-14	1.49314E+00	1.31895E-13
2.17196E+04	2.79298E-13	4.01933E-01	1.12259E-13
2.34572E+04	6.53666E-13	1.06131E-01	6.93740E-14
2.51948E+04	1.07203E-12	2.75651E-02	2.95506E-14
2.69323E+04	1.27859E-12	7.05776E-03	9.02045E-15
2.86699E+04	1.09839E-12	1.78459E-03	1.96017E-15
3.04075E+04	6.78409E-13	4.46291E-04	3.02767E-16
3.21450E+04	3.06857E-13	1.10518E-04	3.39133E-17
3.38826E+04	1.14048E-13	2.71293E-05	3.09404E-18
3.56202E+04	6.55399E-12	6.60713E-06	4.33031E-17
3.73578E+04	1.59082E-09	1.59765E-06	2.54158E-15
3.90953E+04	6.20525E-07	3.83823E-07	2.38172E-13
4.08329E+04	8.96574E-05	9.16649E-08	8.21844E-12
4.25705E+04	3.37868E-03	2.17728E-08	7.35633E-11
4.43080E+04	3.26404E-02	5.14579E-09	1.67961E-10
4.60456E+04	8.07878E-02	1.21056E-09	9.77910E-11
4.77832E+04	5.12166E-02	2.83571E-10	1.45235E-11
4.95207E+04	8.31865E-03	6.61628E-11	5.50379E-13
5.12583E+04	3.46769E-04	1.53802E-11	5.33336E-15
5.29959E+04	1.99252E-05	3.56296E-12	7.09928E-17
5.47335E+04	2.22519E-04	8.22733E-13	1.83074E-16
5.64710E+04	1.68094E-03	1.89406E-13	3.18380E-16
5.82086E+04	6.99651E-03	4.34804E-14	3.04211E-16
5.99462E+04	1.60536E-02	9.95480E-15	1.59811E-16
6.16837E+04	2.09227E-02	2.27340E-15	4.75657E-17
6.34213E+04	2.96581E-02	5.17948E-16	1.53613E-17
6.51589E+04	1.04056E-01	1.17738E-16	1.22514E-17
6.68964E+04	1.64566E-01	2.67068E-17	4.39475E-18

J TOTAL = 5.92588E-05

PLANCK MEAN OPACITY = 4.29774E-12 MEAN-SQUARED PLANCK MEAN OPACITY = 1.81210E-15
ROSSELAND MEAN-FREE-PATH = 1.15494E+12 1/ROSSELAND MEAN-FREE-PATH = 8.65847E-13
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 3.90934E+24 I PRIME = 6.33644E+24

TEMPERATURE = 2.20000E+03 C/H MASS RATIO = 5.00000E-03 PRESSURE = 1.00000E+02

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	1.53285E-07	3.44477E+04	5.28031E-03
9.55663E+03	1.50382E-06	2.01055E+04	3.02350E-02
1.12942E+04	4.45387E-06	1.06385E+04	4.73826E-02
1.30318E+04	3.98250E-06	5.24356E+03	2.08825E-02
1.47693E+04	1.07567E-06	2.44977E+03	2.63516E-03
1.65069E+04	8.78478E-08	1.09775E+03	9.64352E-05
1.82445E+04	2.33949E-09	4.75752E+02	1.11301E-06
1.99821E+04	5.76150E-10	2.00626E+02	1.15591E-07
2.17196E+04	1.48455E-09	8.27006E+01	1.22773E-07
2.34572E+04	5.53474E-09	3.34398E+01	1.85081E-07
2.51948E+04	5.33347E-09	1.33000E+01	7.09350E-08
2.69323E+04	5.54256E-09	5.21466E+00	2.89026E-08
2.86699E+04	4.95410E-09	2.01914E+00	1.00031E-08
3.04075E+04	3.25753E-09	7.73240E-01	2.51885E-09
3.21450E+04	3.02821E-09	2.93224E-01	8.87945E-10
3.38826E+04	7.06205E-10	1.10223E-01	7.78401E-11
3.56202E+04	5.57579E-09	4.11069E-02	2.29179E-10
3.73578E+04	2.71947E-07	1.52213E-02	4.13939E-09
3.90953E+04	8.29638E-06	5.59976E-03	4.64577E-08
4.08329E+04	3.70228E-04	2.04790E-03	7.58191E-07
4.25705E+04	8.57627E-03	7.44884E-04	6.38833E-06
4.43080E+04	6.27692E-02	2.69585E-04	1.69216E-05
4.60456E+04	1.39172E-01	9.71173E-05	1.35160E-05
4.77832E+04	9.32445E-02	3.48371E-05	3.24836E-06
4.95207E+04	1.88764E-02	1.24469E-05	2.34953E-07
5.12583E+04	1.15913E-03	4.43076E-06	5.13581E-09
5.29959E+04	6.62134E-05	1.57180E-06	1.04074E-10
5.47335E+04	3.62456E-04	5.55792E-07	2.01451E-10
5.64710E+04	1.94193E-03	1.95937E-07	3.80495E-10
5.82086E+04	5.93417E-03	6.88786E-08	4.08737E-10
5.99462E+04	1.02651E-02	2.41486E-08	2.47888E-10
6.16837E+04	1.34643E-02	8.44507E-09	1.13707E-10
6.34213E+04	4.43328E-02	2.94633E-09	1.30619E-10
6.51589E+04	2.04052E-01	1.02561E-09	2.09277E-10
6.68964E+04	2.94872E-01	3.56249E-10	1.05048E-10

J TOTAL = 1.85146E+02

PLANCK MEAN OPACITY = 1.42458E-06 MEAN-SQUARED PLANCK MEAN OPACITY = 4.87854E-11
ROSSELAND MEAN-FREE-PATH = 1.98219E+07 1/ROSSELAND MEAN-FREE-PATH = 5.04493E-08
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 2.01422E+16 I PRIME = 4.73257E+16

TEMPERATURE = 2.20000E+03 C/H MASS RATIO = 1.00000E-02 PRESSURE = 1.00000E+02

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	6.02547E-07	3.44477E+04	2.07564E-02
9.55663E+03	5.91759E-06	2.01055E+04	1.18976E-01
1.12942E+04	1.75276E-05	1.06385E+04	1.86467E-01
1.30318E+04	1.56726E-05	5.24356E+03	8.21805E-02
1.47693E+04	4.23306E-06	2.44977E+03	1.03700E-02
1.65069E+04	3.45550E-07	1.09775E+03	3.79329E-04
1.82445E+04	8.86479E-09	4.75752E+02	4.21744E-06
1.99821E+04	1.18618E-09	2.00626E+02	2.37980E-07
2.17196E+04	2.98245E-09	8.27006E+01	2.46650E-07
2.34572E+04	1.14844E-08	3.34398E+01	3.84037E-07
2.51948E+04	1.13737E-08	1.33000E+01	1.51270E-07
2.69323E+04	1.11170E-08	5.21466E+00	5.79715E-08
2.86699E+04	9.82138E-09	2.01914E+00	1.98308E-08
3.04075E+04	6.46121E-09	7.73240E-01	4.99606E-09
3.21450E+04	6.03677E-09	2.93224E-01	1.77013E-09
3.38826E+04	1.63109E-09	1.10223E-01	1.79784E-10
3.56202E+04	2.15668E-08	4.11069E-02	8.86545E-10
3.73578E+04	1.03727E-06	1.52213E-02	1.57887E-08
3.90953E+04	2.40853E-05	5.59976E-03	1.34872E-07
4.08329E+04	7.69258E-04	2.04790E-03	1.57537E-06
4.25705E+04	1.70453E-02	7.44884E-04	1.26968E-05
4.43080E+04	1.24408E-01	2.69585E-04	3.35385E-05
4.60456E+04	2.75792E-01	9.71173E-05	2.67842E-05
4.77832E+04	1.84779E-01	3.48371E-05	6.43715E-06
4.95207E+04	3.74084E-02	1.24469E-05	4.65619E-07
5.12583E+04	2.30611E-03	4.43076E-06	1.02178E-08
5.29959E+04	2.18606E-04	1.57180E-06	3.43605E-10
5.47335E+04	1.42406E-03	5.55792E-07	7.91479E-10
5.64710E+04	7.63118E-03	1.95937E-07	1.49523E-09
5.82086E+04	2.33111E-02	6.88786E-08	1.60564E-09
5.99462E+04	4.02009E-02	2.41486E-08	9.70794E-10
6.16837E+04	4.84999E-02	8.44507E-09	4.09585E-10
6.34213E+04	1.04222E-01	2.94633E-09	3.07071E-10
6.51589E+04	4.47456E-01	1.02561E-09	4.58914E-10
6.68964E+04	6.06936E-01	3.56249E-10	2.16220E-10

J TOTAL = 7.28418E+02

PLANCK MEAN OPACITY = 5.60471E-06 MEAN-SQUARED PLANCK MEAN OPACITY = 2.44678E-10
ROSSELAND MEAN-FREE-PATH = 7.80852E+06 1/ROSSELAND MEAN-FREE-PATH = 1.28065E-07
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 4.39623E+15 I PRIME = 1.04210E+16

TEMPERATURE = 2.20000E+03 C/H MASS RATIO = 5.00000E-02 PRESSURE = 1.00000E+02

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	1.33267E-05	3.44477E+04	4.59076E-01
9.55663E+03	1.30992E-04	2.01055E+04	2.63366E+00
1.12942E+04	3.88015E-04	1.06385E+04	4.12791E+00
1.30318E+04	3.46954E-04	5.24356E+03	1.81928E+00
1.47693E+04	9.37074E-05	2.44977E+03	2.29562E-01
1.65069E+04	7.64672E-06	1.09775E+03	8.39421E-03
1.82445E+04	1.90190E-07	4.75752E+02	9.04830E-05
1.99821E+04	7.13935E-09	2.00626E+02	1.43234E-06
2.17196E+04	1.87400E-08	8.27006E+01	1.54981E-06
2.34572E+04	1.22165E-07	3.34398E+01	4.08516E-06
2.51948E+04	1.60819E-07	1.33000E+01	2.13889E-06
2.69323E+04	6.98456E-08	5.21466E+00	3.64221E-07
2.86699E+04	4.63960E-08	2.01914E+00	9.36803E-08
3.04075E+04	3.06349E-08	7.73240E-01	2.36881E-08
3.21450E+04	2.98890E-08	2.93224E-01	8.76418E-09
3.38826E+04	1.65828E-08	1.10223E-01	1.82781E-09
3.56202E+04	4.71064E-07	4.11069E-02	1.93640E-08
3.73578E+04	2.23304E-05	1.52213E-02	3.39899E-07
3.90953E+04	3.80647E-04	5.59976E-03	2.13153E-06
4.08329E+04	4.83802E-03	2.04790E-03	9.90780E-06
4.25705E+04	8.12809E-02	7.44884E-04	6.05448E-05
4.43080E+04	5.81151E-01	2.69585E-04	1.56669E-04
4.60456E+04	1.28676E+00	9.71173E-05	1.24966E-04
4.77832E+04	8.62080E-01	3.48371E-05	3.00323E-05
4.95207E+04	1.74590E-01	1.24469E-05	2.17311E-06
5.12583E+04	1.10779E-02	4.43076E-06	4.90837E-08
5.29959E+04	4.06556E-03	1.57180E-06	6.39022E-09
5.47335E+04	3.12404E-02	5.55792E-07	1.73632E-08
5.64710E+04	1.67526E-01	1.95937E-07	3.28244E-08
5.82086E+04	5.11695E-01	6.88786E-08	3.52448E-08
5.99462E+04	8.80265E-01	2.41486E-08	2.12571E-08
6.16837E+04	9.89014E-01	8.44507E-09	8.35229E-09
6.34213E+04	1.06670E+00	2.94633E-09	3.14284E-09
6.51589E+04	3.63496E+00	1.02561E-09	3.72804E-09
6.68964E+04	3.70964E+00	3.56249E-10	1.32155E-09

J TOTAL = 1.61218E+04

PLANCK MEAN OPACITY = 1.24047E-04 MEAN-SQUARED PLANCK MEAN OPACITY = 3.86210E-08
ROSSELAND MEAN-FREE-PATH = 1.02623E+06 1/ROSSELAND MEAN-FREE-PATH = 9.74443E-07
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 1.16557E+14 I PRIME = 2.77015E+14

TEMPERATURE = 2.20000E+03 C/H MASS RATIO = 5.00000E-03 PRESSURE = 5.00000E+02

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	1.46627E-08	3.44477E+04	5.05096E-04
9.55663E+03	1.40884E-07	2.01055E+04	2.83253E-03
1.12942E+04	4.16609E-07	1.06385E+04	4.43211E-03
1.30318E+04	3.72471E-07	5.24356E+03	1.95308E-03
1.47693E+04	1.00664E-07	2.44977E+03	2.46603E-04
1.65069E+04	8.29412E-09	1.09775E+03	9.10490E-06
1.82445E+04	3.81197E-10	4.75752E+02	1.81355E-07
1.99821E+04	5.64914E-10	2.00626E+02	1.13337E-07
2.17196E+04	1.50785E-09	8.27006E+01	1.24700E-07
2.34572E+04	4.20213E-09	3.34398E+01	1.40518E-07
2.51948E+04	5.02591E-09	1.33000E+01	6.68445E-08
2.69323E+04	5.61159E-09	5.21466E+00	2.92625E-08
2.86699E+04	4.97301E-09	2.01914E+00	1.00412E-08
3.04075E+04	3.27593E-09	7.73240E-01	2.53308E-09
3.21450E+04	2.26645E-09	2.93224E-01	6.64577E-10
3.38826E+04	6.15142E-10	1.10223E-01	6.78028E-11
3.56202E+04	1.29039E-09	4.11069E-02	5.30441E-11
3.73578E+04	9.08478E-08	1.52213E-02	1.38282E-09
3.90953E+04	1.08293E-05	5.59976E-03	6.06415E-08
4.08329E+04	8.08734E-04	2.04790E-03	1.65621E-06
4.25705E+04	1.95591E-02	7.44884E-04	1.45693E-05
4.43080E+04	1.43520E-01	2.69585E-04	3.86908E-05
4.60456E+04	3.18259E-01	9.71173E-05	3.09085E-05
4.77832E+04	2.13234E-01	3.48371E-05	7.42844E-06
4.95207E+04	4.31652E-02	1.24469E-05	5.37274E-07
5.12583E+04	2.64377E-03	4.43076E-06	1.17139E-08
5.29959E+04	9.34848E-05	1.57180E-06	1.46939E-10
5.47335E+04	3.48063E-04	5.55792E-07	1.93451E-10
5.64710E+04	1.72078E-03	1.95937E-07	3.37163E-10
5.82086E+04	5.24672E-03	6.88786E-08	3.61387E-10
5.99462E+04	9.94731E-03	2.41486E-08	2.40213E-10
6.16837E+04	1.68202E-02	8.44507E-09	1.42047E-10
6.34213E+04	9.13883E-02	2.94633E-09	2.69260E-10
6.51589E+04	4.26004E-01	1.02561E-09	4.36913E-10
6.68964E+04	6.57059E-01	3.56249E-10	2.34077E-10

J TOTAL = 1.75026E+01

PLANCK MEAN OPACITY = 1.34672E-07 MEAN-SQUARED PLANCK MEAN OPACITY = 2.31115E-10
ROSSELAND MEAN-FREE-PATH = 7.50888E+07 1/ROSSELAND MEAN-FREE-PATH = 1.33176E-08
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 1.03436E+17 I PRIME = 2.21340E+17

TEMPERATURE = 2.20000E+03 C/H MASS RATIO = 1.00000E-02 PRESSURE = 5.00000E+02

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	5.80919E-08	3.44477E+04	2.00114E-03
9.55663E+03	5.64580E-07	2.01055E+04	1.13512E-02
1.12942E+04	1.67096E-06	1.06385E+04	1.77765E-02
1.30318E+04	1.49403E-06	5.24356E+03	7.83404E-03
1.47693E+04	4.03645E-07	2.44977E+03	9.88837E-04
1.65069E+04	3.30963E-08	1.09775E+03	3.63316E-05
1.82445E+04	1.16978E-09	4.75752E+02	5.56525E-07
1.99821E+04	1.13455E-09	2.00626E+02	2.27620E-07
2.17196E+04	3.01933E-09	8.27006E+01	2.49700E-07
2.34572E+04	8.41796E-09	3.34398E+01	2.81495E-07
2.51948E+04	1.00692E-08	1.33000E+01	1.33921E-07
2.69323E+04	1.12357E-08	5.21466E+00	5.85905E-08
2.86699E+04	9.95622E-09	2.01914E+00	2.01030E-08
3.04075E+04	6.55900E-09	7.73240E-01	5.07168E-09
3.21450E+04	4.54095E-09	2.93224E-01	1.33152E-09
3.38826E+04	1.26046E-09	1.10223E-01	1.38932E-10
3.56202E+04	4.75026E-09	4.11069E-02	1.95268E-10
3.73578E+04	2.88748E-07	1.52213E-02	4.39513E-09
3.90953E+04	2.33120E-05	5.59976E-03	1.30542E-07
4.08329E+04	1.62569E-03	2.04790E-03	3.32926E-06
4.25705E+04	3.91425E-02	7.44884E-04	2.91566E-05
4.43080E+04	2.87143E-01	2.69585E-04	7.74095E-05
4.60456E+04	6.36738E-01	9.71173E-05	6.18383E-05
4.77832E+04	4.26614E-01	3.48371E-05	1.48620E-05
4.95207E+04	8.63606E-02	1.24469E-05	1.07492E-06
5.12583E+04	5.29683E-03	4.43076E-06	2.34690E-08
5.29959E+04	2.76346E-04	1.57180E-06	4.34359E-10
5.47335E+04	1.39231E-03	5.55792E-07	7.73837E-10
5.64710E+04	6.88512E-03	1.95937E-07	1.34905E-09
5.82086E+04	2.09514E-02	6.88786E-08	1.44310E-09
5.99462E+04	3.93168E-02	2.41486E-08	9.49444E-10
6.16837E+04	5.61971E-02	8.44507E-09	4.74588E-10
6.34213E+04	1.98557E-01	2.94633E-09	5.85013E-10
6.51589E+04	8.62363E-01	1.02561E-09	8.84445E-10
6.68964E+04	1.31030E+00	3.56249E-10	4.66793E-10

J TOTAL = 6.98111E+01

PLANCK MEAN OPACITY = 5.37152E-07 MEAN-SQUARED PLANCK MEAN OPACITY = 9.25602E-10
ROSSELAND MEAN-FREE-PATH = 2.41795E+07 1/ROSSELAND MEAN-FREE-PATH = 4.13574E-08
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 1.35305E+16 I PRIME = 2.96992E+16

TEMPERATURE = 2.20000E+03 C/H MASS RATIO = 5.00000E-02 PRESSURE = 5.00000E+02

OMEGA	TOTAL MU	B(W,T)	
7.81906E+03	1.47023E-06	3.44477E+04	5.06460E-02
9.55663E+03	1.44216E-05	2.01055E+04	2.89954E-01
1.12942E+04	4.27122E-05	1.06385E+04	4.54395E-01
1.30318E+04	3.81918E-05	5.24356E+03	2.00261E-01
1.47693E+04	1.03157E-05	2.44977E+03	2.52710E-02
1.65069E+04	8.42509E-07	1.09775E+03	9.24867E-04
1.82445E+04	2.25530E-08	4.75752E+02	1.07296E-05
1.99821E+04	5.85523E-09	2.00626E+02	1.17471E-06
2.17196E+04	1.52528E-08	8.27006E+01	1.26142E-06
2.34572E+04	4.31448E-08	3.34398E+01	1.44275E-06
2.51948E+04	5.18520E-08	1.33000E+01	6.89630E-07
2.69323E+04	5.67276E-08	5.21466E+00	2.95816E-07
2.86699E+04	5.01031E-08	2.01914E+00	1.01165E-07
3.04075E+04	3.30257E-08	7.73240E-01	2.55367E-08
3.21450E+04	2.30051E-08	2.93224E-01	6.74564E-09
3.38826E+04	7.54412E-09	1.10223E-01	8.31537E-10
3.56202E+04	1.12387E-07	4.11069E-02	4.61987E-09
3.73578E+04	5.81519E-06	1.52213E-02	8.85150E-08
3.90953E+04	1.84090E-04	5.59976E-03	1.03086E-06
4.08329E+04	8.46559E-03	2.04790E-03	1.73367E-05
4.25705E+04	1.96736E-01	7.44884E-04	1.46546E-04
4.43080E+04	1.44018E+00	2.69585E-04	3.88251E-04
4.60456E+04	3.19321E+00	9.71173E-05	3.10116E-04
4.77832E+04	2.13943E+00	3.48371E-05	7.45316E-05
4.95207E+04	4.33111E-01	1.24469E-05	5.39091E-06
5.12583E+04	2.68669E-02	4.43076E-06	1.19041E-07
5.29959E+04	5.01019E-03	1.57180E-06	7.87500E-09
5.47335E+04	3.52141E-02	5.55792E-07	1.95718E-08
5.64710E+04	1.74210E-01	1.95937E-07	3.41340E-08
5.82086E+04	5.29775E-01	6.88786E-08	3.64901E-08
5.99462E+04	9.88597E-01	2.41486E-08	2.38732E-08
6.16837E+04	1.21342E+00	8.44507E-09	1.02474E-08
6.34213E+04	1.69505E+00	2.94633E-09	4.99418E-09
6.51589E+04	4.95530E+00	1.02561E-09	5.08219E-09
6.68964E+04	6.91158E+00	3.56249E-10	2.46224E-09

J TOTAL = 1.77651E+03

PLANCK MEAN OPACITY = 1.36691E-05 MEAN-SQUARED PLANCK MEAN OPACITY = 2.36891E-09
ROSSELAND MEAN-FREE-PATH = 2.00009E+06 1/ROSSELAND MEAN-FREE-PATH = 4.99978E-07
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 1.97435E+14 I PRIME = 4.63375E+14

TEMPERATURE = 2.20000E+03 C/H MASS RATIO = 5.00000E-03 PRESSURE = 1.00000E+03

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	5.45648E-09	3.44477E+04	1.87964E-04
9.55663E+03	5.03620E-08	2.01055E+04	1.01255E-03
1.12942E+04	1.48466E-07	1.06385E+04	1.57946E-03
1.30318E+04	1.32703E-07	5.24356E+03	6.95839E-04
1.47693E+04	3.59066E-08	2.44977E+03	8.79630E-05
1.65069E+04	3.01054E-09	1.09775E+03	3.30483E-06
1.82445E+04	2.51457E-10	4.75752E+02	1.19631E-07
1.99821E+04	5.64909E-10	2.00626E+02	1.13336E-07
2.17196E+04	1.51240E-09	8.27006E+01	1.25077E-07
2.34572E+04	3.89017E-09	3.34398E+01	1.30087E-07
2.51948E+04	4.97291E-09	1.33000E+01	6.61396E-08
2.69323E+04	5.62204E-09	5.21466E+00	2.93171E-08
2.86699E+04	4.96746E-09	2.01914E+00	1.00300E-08
3.04075E+04	3.27405E-09	7.73240E-01	2.53163E-09
3.21450E+04	2.07939E-09	2.93224E-01	6.09727E-10
3.38826E+04	6.08785E-10	1.10223E-01	6.71022E-11
3.56202E+04	7.68384E-10	4.11069E-02	3.15859E-11
3.73578E+04	8.01916E-08	1.52213E-02	1.22062E-09
3.90953E+04	1.46194E-05	5.59976E-03	8.18649E-08
4.08329E+04	1.14424E-03	2.04790E-03	2.34330E-06
4.25705E+04	2.77528E-02	7.44884E-04	2.06726E-05
4.43080E+04	2.03677E-01	2.69585E-04	5.49083E-05
4.60456E+04	4.51664E-01	9.71173E-05	4.38644E-05
4.77832E+04	3.02615E-01	3.48371E-05	1.05422E-05
4.95207E+04	6.12586E-02	1.24469E-05	7.62481E-07
5.12583E+04	3.75036E-03	4.43076E-06	1.66170E-08
5.29959E+04	1.14206E-04	1.57180E-06	1.79508E-10
5.47335E+04	3.47657E-04	5.55792E-07	1.93225E-10
5.64710E+04	1.69852E-03	1.95937E-07	3.32802E-10
5.82086E+04	5.18919E-03	6.88786E-08	3.57424E-10
5.99462E+04	1.00659E-02	2.41486E-08	2.43076E-10
6.16837E+04	1.93983E-02	8.44507E-09	1.63820E-10
6.34213E+04	1.27079E-01	2.94633E-09	3.74418E-10
6.51589E+04	6.02800E-01	1.02561E-09	6.18236E-10
6.68964E+04	9.37517E-01	3.56249E-10	3.33990E-10

J TOTAL = 6.43053E+00

PLANCK MEAN OPACITY = 4.94789E-08 MEAN-SQUARED PLANCK MEAN OPACITY = 4.65393E-10
ROSSELAND MEAN-FREE-PATH = 1.45337E+08 1/ROSSELAND MEAN-FREE-PATH = 6.88056E-09
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 2.24207E+17 I PRIME = 4.60806E+17

TEMPERATURE = 2.20000E+03 C/H MASS RATIO = 1.00000E-02 PRESSURE = 1.00000E+03

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	2.11753E-08	3.44477E+04	7.29441F-04
9.55663E+03	2.01608E-07	2.01055E+04	4.05343F-03
1.12942E+04	5.95766E-07	1.06385E+04	6.33807F-03
1.30318F+04	5.32617E-07	5.24356E+03	2.79281F-03
1.47693E+04	1.43983E-07	2.44977E+03	3.52725F-04
1.65069E+04	1.19099E-08	1.09775E+03	1.30742F-05
1.82445F+04	6.48676E-10	4.75752E+02	3.08608F-07
1.99821E+04	1.13286E-09	2.00626E+02	2.27281F-07
2.17196E+04	3.02980E-09	8.27006E+01	2.50566F-07
2.34572E+04	7.79326E-09	3.34398E+01	2.60605F-07
2.51948E+04	9.96273E-09	1.33000E+01	1.32504E-07
2.69323E+04	1.12624E-08	5.21466E+00	5.87295F-08
2.86699E+04	9.95095E-09	2.01914E+00	2.00924F-08
3.04075E+04	6.55882E-09	7.73240E-01	5.07154F-09
3.21450E+04	4.16637E-09	2.93224E-01	1.22168F-09
3.38826E+04	1.23138E-09	1.10223E-01	1.35726E-10
3.56202E+04	2.61835E-09	4.11069E-02	1.07632E-10
3.73578E+04	2.14386E-07	1.52213E-02	3.26324F-09
3.90953E+04	3.00961E-05	5.59976E-03	1.68531F-07
4.08329E+04	2.29456E-03	2.04790E-03	4.69904F-06
4.25705E+04	5.55648E-02	7.44884E-04	4.13893E-05
4.43080E+04	4.07752E-01	2.69585E-04	1.09924F-04
4.60456E+04	9.04204E-01	9.71173E-05	8.78139F-05
4.77832E+04	6.05817E-01	3.48371E-05	2.11049F-05
4.95207E+04	1.22636E-01	1.24469E-05	1.52645F-06
5.12583E+04	7.51535E-03	4.43076E-06	3.32987F-08
5.29959E+04	3.18079E-04	1.57180E-06	4.99955F-10
5.47335E+04	1.38872E-03	5.55792E-07	7.71839F-10
5.64710E+04	6.78605E-03	1.95937E-07	1.32963F-09
5.82086E+04	2.06496E-02	6.88786E-08	1.42231F-09
5.99462E+04	3.93553E-02	2.41486E-08	9.50373F-10
6.16837E+04	6.09915E-02	8.44507E-09	5.15078E-10
6.34213E+04	2.68474E-01	2.94633E-09	7.91012F-10
6.51589E+04	1.20692E+00	1.02561E-09	1.23782F-09
6.68964E+04	1.85638E+00	3.56249E-10	6.61335F-10

J TOTAL = 2.52773E+01

PLANCK MEAN OPACITY = 1.94493E-07 MEAN-SQUARED PLANCK MEAN OPACITY = 1.86526E-09
ROSSELAND MEAN-FREE-PATH = 4.64259E+07 1/ROSSELAND MEAN-FREE-PATH = 2.15397E-08
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 3.42121E+16 I PRIME = 7.24213E+16

TEMPERATURE = 2.20000E+03 C/H MASS RATIO = 5.00000E-02 PRESSURE = 1.00000E+03

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	5.30611E-07	3.44477E+04	1.82784E-02
9.55663E+03	5.18349E-06	2.01055E+04	1.04217E-01
1.12942E+04	1.53472E-05	1.06385E+04	1.63271E-01
1.30318E+04	1.37226E-05	5.24356E+03	7.19553E-02
1.47693E+04	3.70692E-06	2.44977E+03	9.08110E-03
1.65069E+04	3.03281E-07	1.09775E+03	3.32927E-04
1.82445E+04	9.27115E-09	4.75752E+02	4.41077E-06
1.99821E+04	5.77405E-09	2.00626E+02	1.15843E-06
2.17196E+04	1.53171E-08	8.27006E+01	1.26673E-06
2.34572E+04	3.95000E-08	3.34398E+01	1.32087E-06
2.51948E+04	5.04930E-08	1.33000E+01	6.71555E-07
2.69323E+04	5.69276E-08	5.21466E+00	2.96859E-07
2.86699E+04	5.02795E-08	2.01914E+00	1.01522E-07
3.04075E+04	3.31464E-08	7.73240E-01	2.56301E-08
3.21450E+04	2.11141E-08	2.93224E-01	6.19115E-09
3.38826E+04	6.72508E-09	1.10223E-01	7.41259E-10
3.56202E+04	5.77558E-08	4.11069E-02	2.37416E-09
3.73578E+04	3.29943E-06	1.52213E-02	5.02217E-08
3.90953E+04	1.85701E-04	5.59976E-03	1.03988E-06
4.08329E+04	1.17116E-02	2.04790E-03	2.39843E-05
4.25705E+04	2.79977E-01	7.44884E-04	2.08550E-04
4.43080E+04	2.05300E+00	2.69585E-04	5.53459E-04
4.60456E+04	4.55241E+00	9.71173E-05	4.42118E-04
4.77832E+04	3.05011E+00	3.48371E-05	1.06257E-04
4.95207E+04	6.17455E-01	1.24469E-05	7.68543E-06
5.12583E+04	3.81403E-02	4.43076E-06	1.68991E-07
5.29959E+04	5.27167E-03	1.57180E-06	8.28598E-09
5.47335E+04	3.53928E-02	5.55792E-07	1.96711E-08
5.64710E+04	1.73020E-01	1.95937E-07	3.39009E-08
5.82086E+04	5.25801E-01	6.88786E-08	3.62164E-08
5.99462E+04	9.93217E-01	2.41486E-08	2.39848E-08
6.16837E+04	1.25015E+00	8.44507E-09	1.05576E-08
6.34213E+04	2.05359E+00	2.94633E-09	6.05057E-09
6.51589E+04	6.53015E+00	1.02561E-09	6.69736E-09
6.68964E+04	9.54597E+00	3.56249E-10	3.40074E-09

J TOTAL = 6.40274E+02

PLANCK MEAN OPACITY = 4.92650E-06 MEAN-SQUARED PLANCK MEAN OPACITY = 4.73374E-08
ROSSELAND MEAN-FREE-PATH = 3.33670E+06 1/ROSSELAND MEAN-FREE-PATH = 2.99698E-07
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 3.19684E+14 I PRIME = 7.21804E+14

TEMPERATURE = 3.00000E+03 C/H MASS RATIO = 5.00000E-03 PRESSURE = 1.00000E+02

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	3.40367E-04	1.37118E+05	4.66706E+01
9.55663E+03	2.29668E-03	1.07340E+05	2.46524E+02
1.12942E+04	5.69116E-03	7.65548E+04	4.35686E+02
1.30318E+04	5.19702E-03	5.09813E+04	2.64951E+02
1.47693E+04	1.75210E-03	3.22179E+04	5.64490E+01
1.65069E+04	2.18376E-04	1.95386E+04	4.26676E+00
1.82445E+04	1.05379E-05	1.14628E+04	1.20794E-01
1.99821E+04	2.10437E-06	6.54433E+03	1.37717E-02
2.17196E+04	3.68837E-06	3.65236E+03	1.34713E-02
2.34572E+04	2.79473E-05	1.99952E+03	5.58812E-02
2.51948E+04	2.36559E-05	1.07675E+03	2.54715E-02
2.69323E+04	8.53906E-06	5.71600E+02	4.88093E-03
2.86699E+04	4.04971E-06	2.99665E+02	1.21356E-03
3.04075E+04	2.73917E-06	1.55377E+02	4.25605E-04
3.21450E+04	8.80944E-06	7.97768E+01	7.02789E-04
3.38826E+04	1.16440E-06	4.06026E+01	4.72779E-05
3.56202E+04	3.04897E-06	2.05022E+01	6.25106E-05
3.73578E+04	2.64874E-05	1.02788E+01	2.72259E-04
3.90953E+04	3.35714E-04	5.11992E+00	1.71883E-03
4.08329E+04	6.03499E-03	2.53517E+00	1.52997E-02
4.25705E+04	7.68526E-02	1.24851E+00	9.59510E-02
4.43080E+04	3.98660E-01	6.11789E-01	2.43896E-01
4.60456E+04	7.72212E-01	2.98406E-01	2.30433E-01
4.77832E+04	5.53940E-01	1.44929E-01	8.02822E-02
4.95207E+04	1.47798E-01	7.01102E-02	1.03622E-02
5.12583E+04	1.60588E-02	3.37910E-02	5.42643E-04
5.29959E+04	3.04628E-03	1.62302E-02	4.94416E-05
5.47335E+04	6.39271E-03	7.77041E-03	4.96740E-05
5.64710E+04	2.43373E-02	3.70895E-03	9.02658E-05
5.82086E+04	5.92081E-02	1.76532E-03	1.04521E-04
5.99462E+04	7.59609E-02	8.37983E-04	6.36540E-05
6.16837E+04	9.73106E-02	3.96782E-04	3.86111E-05
6.34213E+04	3.73456E-01	1.87428E-04	6.99959E-05
6.51589E+04	1.82800E+00	8.83359E-05	1.61478E-04
6.68964E+04	2.07901E+00	4.15446E-05	8.63714E-05

J TOTAL = 1.83394E+06 .

PLANCK MEAN OPACITY = 2.34717E-03 MEAN-SQUARED PLANCK MEAN OPACITY = 1.08247E-05
ROSSELAND MEAN-FREE-PATH = 2.39068E+04 1/ROSSELAND MEAN-FREE-PATH = 4.18290E-05
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 7.98087E+09 I PRIME = 1.65708E+10

TEMPERATURE = 3.00000E+03 C/H MASS RATIO = 1.00000E-02 PRESSURE = 1.00000E+02

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	8.50038E-04	1.37118E+05	1.16556E+02
9.55663E+03	5.73692E-03	1.07340E+05	6.15799E+02
1.12942E+04	1.42164E-02	7.65548E+04	1.08833E+03
1.30318E+04	1.29821E-02	5.09813E+04	6.61842E+02
1.47693E+04	4.37667E-03	3.22179E+04	1.41007E+02
1.65069E+04	5.45409E-04	1.95386E+04	1.06565E+01
1.82445E+04	2.61319E-05	1.14628E+04	2.99544E-01
1.99821E+04	4.77987E-06	6.54433E+03	3.12810E-02
2.17196E+04	1.05863E-05	3.65236E+03	3.86650E-02
2.34572E+04	7.49971E-05	1.99952E+03	1.49958E-01
2.51948E+04	8.05597E-05	1.07675E+03	8.67424E-02
2.69323E+04	2.46819E-05	5.71600E+02	1.41081E-02
2.86699E+04	6.94076E-06	2.99665E+02	2.07991E-03
3.04075E+04	4.36370E-06	1.55377E+02	6.78019E-04
3.21450E+04	1.40536E-05	7.97768E+01	1.12115E-03
3.38826E+04	2.39932E-06	4.06026E+01	9.74185E-05
3.56202E+04	7.42890E-06	2.05022E+01	1.52309E-04
3.73578E+04	6.48656E-05	1.02788E+01	6.66740E-04
3.90953E+04	7.10479E-04	5.11992E+00	3.63759E-03
4.08329E+04	1.01619E-02	2.53517E+00	2.57622E-02
4.25705E+04	1.22280E-01	1.24851E+00	1.52668E-01
4.43080E+04	6.30330E-01	6.11789E-01	3.85629E-01
4.60456E+04	1.22028E+00	2.98406E-01	3.64139E-01
4.77832E+04	8.75735E-01	1.44929E-01	1.26920E-01
4.95207E+04	2.34570E-01	7.01102E-02	1.64457E-02
5.12583E+04	2.69074E-02	3.37910E-02	9.09229E-04
5.29959E+04	7.07071E-03	1.62302E-02	1.14759E-04
5.47335E+04	1.57517E-02	7.77041E-03	1.22397E-04
5.64710E+04	6.00666E-02	3.70895E-03	2.22784E-04
5.82086E+04	1.45314E-01	1.76532E-03	2.56526E-04
5.99462E+04	1.80503E-01	8.37983E-04	1.51259E-04
6.16837E+04	1.98074E-01	3.96782E-04	7.85920E-05
6.34213E+04	6.37343E-01	1.87428E-04	1.19456E-04
6.51589E+04	3.48454E+00	8.83359E-05	3.07810E-04
6.68964E+04	3.62586E+00	4.15446E-05	1.50635E-04

J TOTAL = 4.58006E+06

PLANCK MEAN OPACITY = 5.86179E-03 MEAN-SQUARED PLANCK MEAN OPACITY = 6.48075E-05
ROSSELAND MEAN-FREE-PATH = 9.99225E+03 1/ROSSELAND MEAN-FREE-PATH = 1.00078E-04
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 1.49562E+09 I PRIME = 3.15693E+09

TEMPERATURE = 3.00000E+03 C/H MASS RATIO = 5.00000E-02 PRESSURE = 1.00000E+02

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	5.85095E-03	1.37118E+05	8.02273E+02
9.55663E+03	3.94972E-02	1.07340E+05	4.23962E+03
1.12942E+04	9.78785E-02	7.65548E+04	7.49307E+03
1.30318E+04	8.93804E-02	5.09813E+04	4.55673E+03
1.47693E+04	3.01326E-02	3.22179E+04	9.70811E+02
1.65069E+04	3.75442E-03	1.95386E+04	7.33561E+01
1.82445E+04	1.78423E-04	1.14628E+04	2.04522E+00
1.99821E+04	3.03020E-05	6.54433E+03	1.98306E-01
2.17196E+04	1.36568E-04	3.65236E+03	4.98797E-01
2.34572E+04	9.64969E-04	1.99952E+03	1.92947E+00
2.51948E+04	1.28996E-03	1.07675E+03	1.38896E+00
2.69323E+04	3.44127E-04	5.71600E+02	1.96703E-01
2.86699E+04	3.14737E-05	2.99665E+02	9.43157E-03
3.04075E+04	1.18017E-05	1.55377E+02	1.83371E-03
3.21450E+04	3.81060E-05	7.97768E+01	3.03998E-03
3.38826E+04	1.27566E-05	4.06026E+01	5.17953E-04
3.56202E+04	4.95338E-05	2.05022E+01	1.01555E-03
3.73578E+04	4.30700E-04	1.02788E+01	4.42708E-03
3.90953E+04	3.88308E-03	5.11992E+00	1.98811E-02
4.08329E+04	3.34226E-02	2.53517E+00	8.47321E-02
4.25705E+04	3.26387E-01	1.24851E+00	4.07496E-01
4.43080E+04	1.63765E+00	6.11789E-01	1.00189E+00
4.60456E+04	3.16268E+00	2.98406E-01	9.43761E-01
4.77832E+04	2.27412E+00	1.44929E-01	3.29587E-01
4.95207E+04	6.19810E-01	7.01102E-02	4.34550E-02
5.12583E+04	8.76655E-02	3.37910E-02	2.96231E-03
5.29959E+04	4.47342E-02	1.62302E-02	7.26044E-04
5.47335E+04	1.06181E-01	7.77041E-03	8.25068E-04
5.64710E+04	4.03315E-01	3.70895E-03	1.49587E-03
5.82086E+04	9.71720E-01	1.76532E-03	1.71540E-03
5.99462E+04	1.18227E+00	8.37983E-04	9.90726E-04
6.16837E+04	1.08821E+00	3.96782E-04	4.31781E-04
6.34213E+04	2.32926E+00	1.87428E-04	4.36568E-04
6.51589E+04	1.60923E+01	8.83359E-05	1.42152E-03
6.68964E+04	1.37430E+01	4.15446E-05	5.70949E-04

J TOTAL = 3.15282E+07

PLANCK MEAN OPACITY = 4.03514E-02 MEAN-SQUARED PLANCK MEAN OPACITY = 2.99761E-03
ROSSELAND MEAN-FREE-PATH = 1.47741E+03 1/ROSSELAND MEAN-FREE-PATH = 6.76858E-04
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 4.13663E+07 I PRIME = 9.54752E+07

TEMPERATURE = 3.00000E+03 C/H MASS RATIO = 5.00000E-03 PRESSURE = 5.00000E+02

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	1.31669E-04	1.37118E+05	1.80543E+01
9.55663E+03	8.86552E-04	1.07340E+05	9.51623E+01
1.12942E+04	2.19634E-03	7.65548E+04	1.68141E+02
1.30318E+04	2.00560E-03	5.09813E+04	1.02248E+02
1.47693E+04	6.76245E-04	3.22179E+04	2.17872E+01
1.65069E+04	8.44260E-05	1.95386E+04	1.64957E+00
1.82445E+04	4.35649E-06	1.14628E+04	4.99375E-02
1.99821E+04	1.44284E-06	6.54433E+03	9.44244E-03
2.17196E+04	2.71728E-06	3.65236E+03	9.92446E-03
2.34572E+04	1.71796E-05	1.99952E+03	3.43509E-02
2.51948E+04	9.81116E-06	1.07675E+03	1.05641E-02
2.69323E+04	7.82153E-06	5.71600E+02	4.47079E-03
2.86699E+04	7.10617E-06	2.99665E+02	2.12947E-03
3.04075E+04	5.04645E-06	1.55377E+02	7.84103E-04
3.21450E+04	9.53660E-06	7.97768E+01	7.60800E-04
3.38826E+04	1.39352E-06	4.06026E+01	5.65807E-05
3.56202E+04	1.86915E-06	2.05022E+01	3.83217E-05
3.73578E+04	2.48289E-05	1.02788E+01	2.55212E-04
3.90953E+04	8.14665E-04	5.11992E+00	4.17102E-03
4.08329E+04	2.56717E-02	2.53517E+00	6.50823E-02
4.25705E+04	3.56878E-01	1.24851E+00	4.45565E-01
4.43080E+04	1.86801E+00	6.11789E-01	1.14283E+00
4.60456E+04	3.62122E+00	2.98406E-01	1.08059E+00
4.77832E+04	2.59586E+00	1.44929E-01	3.76217E-01
4.95207E+04	6.88341E-01	7.01102E-02	4.82597E-02
5.12583E+04	6.82986E-02	3.37910E-02	2.30788E-03
5.29959E+04	4.99020E-03	1.62302E-02	8.09918E-05
5.47335E+04	1.04681E-02	7.77041E-03	8.13416E-05
5.64710E+04	3.97197E-02	3.70895E-03	1.47318E-04
5.82086E+04	9.81792E-02	1.76532E-03	1.73318E-04
5.99462E+04	1.56894E-01	8.37983E-04	1.31475E-04
6.16837E+04	3.13997E-01	3.96782E-04	1.24588E-04
6.34213E+04	1.54983E+00	1.87428E-04	2.90481E-04
6.51589E+04	5.98064E+00	8.83359E-05	5.28306E-04
6.68964E+04	8.14991E+00	4.15446E-05	3.38585E-04

J TOTAL = 7.12980E+05

PLANCK MEAN OPACITY = 9.12509E-04 MEAN-SQUARED PLANCK MEAN OPACITY = 1.75705E-05
ROSSELAND MEAN-FREE-PATH = 3.88156E+04 1/ROSSELAND MEAN-FREE-PATH = 2.57628E-05
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 1.73559E+10 I PRIME = 3.45945E+10

TEMPERATURE = 3.00000E+03 C/H MASS RATIO = 1.00000E-02 PRESSURE = 5.00000E+02

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	4.59349E-04	1.37118E+05	6.29852E+01
9.55663E+03	3.09720E-03	1.07340E+05	3.32453E+02
1.12942E+04	7.67414E-03	7.65548E+04	5.87492E+02
1.30318E+04	7.00777E-03	5.09813E+04	3.57265E+02
1.47693E+04	2.36269E-03	3.22179E+04	7.61210E+01
1.65069E+04	2.94668E-04	1.95386E+04	5.75741E+00
1.82445E+04	1.45217E-05	1.14628E+04	1.66459E-01
1.99821E+04	3.18253E-06	6.54433E+03	2.08275E-02
2.17196E+04	5.86560E-06	3.65236E+03	2.14233E-02
2.34572E+04	3.64644E-05	1.99952E+03	7.29113E-02
2.51948E+04	2.43966E-05	1.07675E+03	2.62690E-02
2.69323E+04	1.61856E-05	5.71600E+02	9.25166E-03
2.86699E+04	1.33573E-05	2.99665E+02	4.00274E-03
3.04075E+04	9.44985E-06	1.55377E+02	1.46829E-03
3.21450E+04	1.79170E-05	7.97768E+01	1.42936E-03
3.38826E+04	2.98475E-06	4.06026E+01	1.21189E-04
3.56202E+04	5.79464E-06	2.05022E+01	1.18803E-04
3.73578E+04	7.61815E-05	1.02788E+01	7.83054E-04
3.90953E+04	1.78211E-03	5.11992E+00	9.12425E-03
4.08329E+04	4.88834E-02	2.53517E+00	1.23928E-01
4.25705E+04	6.67994E-01	1.24851E+00	8.33995E-01
4.43080E+04	3.49064E+00	6.11789E-01	2.13554E+00
4.60456E+04	6.76572E+00	2.98406E-01	2.01893E+00
4.77832E+04	4.85022E+00	1.44929E-01	7.02938E-01
4.95207E+04	1.28677E+00	7.01102E-02	9.02154E-02
5.12583E+04	1.28927E-01	3.37910E-02	4.35658E-03
5.29959E+04	1.29570E-02	1.62302E-02	2.10294E-04
5.47335E+04	3.47645E-02	7.77041E-03	2.70134E-04
5.64710E+04	1.32711E-01	3.70895E-03	4.92217E-04
5.82086E+04	3.21407E-01	1.76532E-03	5.67387E-04
5.99462E+04	4.70796E-01	8.37983E-04	3.94519E-04
6.16837E+04	7.21616E-01	3.96782E-04	2.86324E-04
6.34213E+04	2.95670E+00	1.87428E-04	5.54167E-04
6.51589E+04	1.19019E+01	8.83359E-05	1.05137E-03
6.68964E+04	1.54425E+01	4.15446E-05	6.41553E-04

J TOTAL = 2.48181E+06

PLANCK MEAN OPACITY = 3.17635E-03 MEAN-SQUARED PLANCK MEAN OPACITY = 7.44542E-05
ROSSELAND MEAN-FREE-PATH = 1.57118E+04 1/ROSSELAND MEAN-FREE-PATH = 6.36466E-05
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 3.33214E+09 I PRIME = 6.71220E+09

TEMPERATURE = 3.00000E+03 C/H MASS RATIO = 5.00000E-02 PRESSURE = 5.00000E+02

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	5.99236E-03	1.37118E+05	8.21662E+02
9.55663E+03	4.04514E-02	1.07340E+05	4.34204E+03
1.12942E+04	1.00241E-01	7.65548E+04	7.67396E+03
1.30318E+04	9.15381E-02	5.09813E+04	4.66673E+03
1.47693E+04	3.08605E-02	3.22179E+04	9.94260E+02
1.65069E+04	3.84554E-03	1.95386E+04	7.51366E+01
1.82445E+04	1.82078E-04	1.14628E+04	2.08712E+00
1.99821E+04	2.19345E-05	6.54433E+03	1.43546E-01
2.17196E+04	6.03020E-05	3.65236E+03	2.20245E-01
2.34572E+04	3.96406E-04	1.99952E+03	7.92623E-01
2.51948E+04	4.59247E-04	1.07675E+03	4.94494E-01
2.69323E+04	1.54522E-04	5.71600E+02	8.83249E-02
2.86699E+04	5.27932E-05	2.99665E+02	1.58203E-02
3.04075E+04	3.44905E-05	1.55377E+02	5.35903E-03
3.21450E+04	6.64812E-05	7.97768E+01	5.30366E-03
3.38826E+04	1.85919E-05	4.06026E+01	7.54881E-04
3.56202E+04	6.78702E-05	2.05022E+01	1.39149E-03
3.73578E+04	8.79437E-04	1.02788E+01	9.03956E-03
3.90953E+04	1.16850E-02	5.11992E+00	5.98265E-02
4.08329E+04	1.94310E-01	2.53517E+00	4.92610E-01
4.25705E+04	2.42480E+00	1.24851E+00	3.02737E+00
4.43080E+04	1.25523E+01	6.11789E-01	7.67938E+00
4.60456E+04	2.43086E+01	2.98406E-01	7.25382E+00
4.77832E+04	1.74309E+01	1.44929E-01	2.52624E+00
4.95207E+04	4.63776E+00	7.01102E-02	3.25154E-01
5.12583E+04	4.90943E-01	3.37910E-02	1.65895E-02
5.29959E+04	1.23090E-01	1.62302E-02	1.99777E-03
5.47335E+04	4.42517E-01	7.77041E-03	3.43854E-03
5.64710E+04	1.69519E+00	3.70895E-03	6.28736E-03
5.82086E+04	4.07196E+00	1.76532E-03	7.18832E-03
5.99462E+04	5.69911E+00	8.37983E-04	4.77576E-03
6.16837E+04	6.34657E+00	3.96782E-04	2.51820E-03
6.34213E+04	1.39055E+01	1.87428E-04	2.60627E-03
6.51589E+04	6.23492E+01	8.83359E-05	5.50767E-03
6.68964E+04	6.73054E+01	4.15446E-05	2.79617E-03

J TOTAL = 3.23172E+07

PLANCK MEAN OPACITY = 4.13612E-02 MEAN-SQUARED PLANCK MEAN OPACITY = 3.85687E-03
ROSSELAND MEAN-FREE-PATH = 1.89218E+03 1/ROSSELAND MEAN-FREE-PATH = 5.28491E-04
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 6.26331E+07 I PRIME = 1.27236E+08

TEMPERATURE = 3.00000E+03 C/H MASS RATIO = 5.00000E-03 PRESSURE = 1.00000E+03

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	5.86381E-05	1.37118E+05	8.04036E+00
9.55663E+03	3.93045E-04	1.07340E+05	4.21893E+01
1.12942E+04	9.73258E-04	7.65548E+04	7.45076E+01
1.30318E+04	8.88698E-04	5.09813E+04	4.53069E+01
1.47693E+04	2.99722E-04	3.22179E+04	9.65640E+00
1.65069E+04	3.75425E-05	1.95386E+04	7.33528E-01
1.82445E+04	2.21445E-06	1.14628E+04	2.53838E-02
1.99821E+04	1.36917E-06	6.54433E+03	8.96029E-03
2.17196E+04	2.81268E-06	3.65236E+03	1.02729E-02
2.34572E+04	1.44676E-05	1.99952E+03	2.89283E-02
2.51948E+04	9.02853E-06	1.07675E+03	9.72144E-03
2.69323E+04	8.32072E-06	5.71600E+02	4.75612E-03
2.86699E+04	7.71383E-06	2.99665E+02	2.31157E-03
3.04075E+04	5.48559E-06	1.55377E+02	8.52335E-04
3.21450E+04	8.37926E-06	7.97768E+01	6.68471E-04
3.38826E+04	1.40608E-06	4.06026E+01	5.70906E-05
3.56202E+04	1.26249E-06	2.05022E+01	2.58838E-05
3.73578E+04	2.12407E-05	1.02788E+01	2.18329E-04
3.90953E+04	1.13814E-03	5.11992E+00	5.82719E-03
4.08329E+04	4.02128E-02	2.53517E+00	1.01947E-01
4.25705E+04	5.65910E-01	1.24851E+00	7.06543E-01
4.43080E+04	2.96564E+00	6.11789E-01	1.81435E+00
4.60456E+04	5.74964E+00	2.98406E-01	1.71573E+00
4.77832E+04	4.12146E+00	1.44929E-01	5.97320E-01
4.95207E+04	1.09244E+00	7.01102E-02	7.65912E-02
5.12583E+04	1.07676E-01	3.37910E-02	3.63850E-03
5.29959E+04	6.52970E-03	1.62302E-02	1.05978E-04
5.47335E+04	1.17257E-02	7.77041E-03	9.11132E-05
5.64710E+04	4.23941E-02	3.70895E-03	1.57238E-04
5.82086E+04	1.06598E-01	1.76532E-03	1.88180E-04
5.99462E+04	1.95463E-01	8.37983E-04	1.63795E-04
6.16837E+04	4.73808E-01	3.96782E-04	1.87998E-04
6.34213E+04	2.46033E+00	1.87428E-04	4.61134E-04
6.51589E+04	9.06041E+00	8.83359E-05	8.00360E-04
6.68964E+04	1.27894E+01	4.15446E-05	5.31331E-04

J TOTAL = 3.22408E+05

PLANCK MEAN OPACITY = 4.12634E-04 MEAN-SQUARED PLANCK MEAN OPACITY = 4.07927E-05
ROSSELAND MEAN-FREE-PATH = 5.27170E+04 1/ROSSELAND MEAN-FREE-PATH = 1.89692E-05
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 2.50813E+10 I PRIME = 4.83798E+10

TEMPERATURE = 3.00000E+03 C/H MASS RATIO = 1.00000E-02 PRESSURE = 1.00000E+03

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	2.22538E-04	1.37118E+05	3.05141E+01
9.55663E+03	1.49717E-03	1.07340E+05	1.60705E+02
1.12942E+04	3.70874E-03	7.65548E+04	2.83922E+02
1.30318E+04	3.38663E-03	5.09813E+04	1.72655E+02
1.47693E+04	1.14195E-03	3.22179E+04	3.67912E+01
1.65069E+04	1.42653E-04	1.95386E+04	2.78725E+00
1.82445E+04	7.54427E-06	1.14628E+04	8.64783E-02
1.99821E+04	2.86067E-06	6.54433E+03	1.87212E-02
2.17196E+04	5.68711E-06	3.65236E+03	2.07714E-02
2.34572E+04	2.91331E-05	1.99952E+03	5.82522E-02
2.51948E+04	1.88714E-05	1.07675E+03	2.03197E-02
2.69323E+04	1.65664E-05	5.71600E+02	9.46935E-03
2.86699E+04	1.50747E-05	2.99665E+02	4.51736E-03
3.04075E+04	1.07166E-05	1.55377E+02	1.66512E-03
3.21450E+04	1.63921E-05	7.97768E+01	1.30771E-03
3.38826E+04	2.93068E-06	4.06026E+01	1.18993E-04
3.56202E+04	3.81156E-06	2.05022E+01	7.81454E-05
3.73578E+04	6.18579E-05	1.02788E+01	6.35825E-04
3.90953E+04	2.40330E-03	5.11992E+00	1.23047E-02
4.08329E+04	7.90622E-02	2.53517E+00	2.00436E-01
4.25705E+04	1.10429E+00	1.24851E+00	1.37872E+00
4.43080E+04	5.78287E+00	6.11789E-01	3.53790E+00
4.60456E+04	1.12108E+01	2.98406E-01	3.34537E+00
4.77832E+04	8.03622E+00	1.44929E-01	1.16468E+00
4.95207E+04	2.13043E+00	7.01102E-02	1.49365E-01
5.12583E+04	2.10862E-01	3.37910E-02	7.12523E-03
5.29959E+04	1.65212E-02	1.62302E-02	2.68142E-04
5.47335E+04	4.06428E-02	7.77041E-03	3.15811E-04
5.64710E+04	1.47972E-01	3.70895E-03	5.48820E-04
5.82086E+04	3.57725E-01	1.76532E-03	6.31499E-04
5.99462E+04	5.73656E-01	8.37983E-04	4.80714E-04
6.16837E+04	1.04745E+00	3.96782E-04	4.15608E-04
6.34213E+04	4.75712E+00	1.87428E-04	8.91616E-04
6.51589E+04	1.78306E+01	8.83359E-05	1.57508E-03
6.68964E+04	2.45065E+01	4.15446E-05	1.01811E-03

J TOTAL = 1.21178E+06

PLANCK MEAN OPACITY = 1.55090E-03 MEAN-SQUARED PLANCK MEAN OPACITY = 1.58263E-04
ROSSELAND MEAN-FREE-PATH = 2.04084E+04 1/ROSSELAND MEAN-FREE-PATH = 4.89995E-05
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 4.53148E+09 I PRIME = 8.96756E+09

TEMPERATURE = 3.00000E+03 C/H MASS RATIO = 5.00000E-02 PRESSURE = 1.00000E+03

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	4.02305E-03	1.37118E+05	5.51634E+02
9.55663E+03	2.71467E-02	1.07340E+05	2.91391E+03
1.12942E+04	6.72682E-02	7.65548E+04	5.14971E+03
1.30318E+04	6.14275E-02	5.09813E+04	3.13165E+03
1.47693E+04	2.07097E-02	3.22179E+04	6.67224E+02
1.65069E+04	2.58146E-03	1.95386E+04	5.04381E+01
1.82445E+04	1.23788E-04	1.14628E+04	1.41895E+00
1.99821E+04	1.77039E-05	6.54433E+03	1.15860E-01
2.17196E+04	3.79889E-05	3.65236E+03	1.38749E-01
2.34572E+04	2.12567E-04	1.99952E+03	4.25032E-01
2.51948E+04	2.04293E-04	1.07675E+03	2.19971E-01
2.69323E+04	1.02457E-04	5.71600E+02	5.85645E-02
2.86699E+04	6.55450E-05	2.99665E+02	1.96416E-02
3.04075E+04	4.57630E-05	1.55377E+02	7.11053E-03
3.21450E+04	7.09890E-05	7.97768E+01	5.66328E-03
3.38826E+04	1.80396E-05	4.06026E+01	7.32453E-04
3.56202E+04	5.52492E-05	2.05022E+01	1.13273E-03
3.73578E+04	8.44261E-04	1.02788E+01	8.67799E-03
3.90953E+04	1.54017E-02	5.11992E+00	7.88555E-02
4.08329E+04	3.53072E-01	2.53517E+00	8.95099E-01
4.25705E+04	4.69644E+00	1.24851E+00	5.86353E+00
4.43080E+04	2.44759E+01	6.11789E-01	1.49741E+01
4.60456E+04	4.74285E+01	2.98406E-01	1.41529E+01
4.77832E+04	3.40009E+01	1.44929E-01	4.92773E+00
4.95207E+04	9.02409E+00	7.01102E-02	6.32681E-01
5.12583E+04	9.20732E-01	3.37910E-02	3.11125E-02
5.29959E+04	1.86521E-01	1.62302E-02	3.02727E-03
5.47335E+04	7.06699E-01	7.77041E-03	5.49134E-03
5.64710E+04	2.58376E+00	3.70895E-03	9.58303E-03
5.82086E+04	6.15059E+00	1.76532E-03	1.08578E-02
5.99462E+04	9.18533E+00	8.37983E-04	7.69715E-03
6.16837E+04	1.11752E+01	3.96782E-04	4.43411E-03
6.34213E+04	2.54617E+01	1.87428E-04	4.77223E-03
6.51589E+04	9.52818E+01	8.83359E-05	8.41680E-03
6.68964E+04	1.14964E+02	4.15446E-05	4.77614E-03

J TOTAL = 2.17346E+07

PLANCK MEAN OPACITY = 2.78170E-02 MEAN-SQUARED PLANCK MEAN OPACITY = 4.16888E-03
ROSSELAND MEAN-FREE-PATH = 2.50494E+03 1/ROSSELAND MEAN-FREE-PATH = 3.99211E-04
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 9.97779E+07 I PRIME = 2.01041E+08

TEMPERATURE = 4.00000E+03 C/H MASS RATIO = 5.00000E-03 PRESSURE = 1.00000E+02

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	4.04493E-03	3.63754E+05	1.47136E+03
9.55663E+03	1.90479E-02	3.45236E+05	6.57601E+03
1.12942E+04	4.00347E-02	3.00388E+05	1.20260E+04
1.30318E+04	3.74242E-02	2.45004E+05	9.16909E+03
1.47693E+04	1.56084E-02	1.90082E+05	2.96688E+03
1.65069E+04	2.93186E-03	1.41717E+05	4.15495E+02
1.82445E+04	3.46926E-04	1.02295E+05	3.54886E+01
1.99821E+04	3.65439E-04	7.18885E+04	2.62708E+01
2.17196E+04	4.07430E-04	4.93980E+04	2.01262E+01
2.34572E+04	1.73128E-03	3.33016E+04	5.76546E+01
2.51948E+04	1.04593E-03	2.20847E+04	2.30989E+01
2.69323E+04	3.92129E-04	1.44386E+04	5.66179E+00
2.86699E+04	1.36717E-04	9.32257E+03	1.27455E+00
3.04075E+04	9.91626E-05	5.95330E+03	5.90344E-01
3.21450E+04	5.98826E-04	3.76462E+03	2.25435E+00
3.38826E+04	4.03105E-05	2.35980E+03	9.51245E-02
3.56202E+04	7.42106E-05	1.46757E+03	1.08909E-01
3.73578E+04	1.96602E-04	9.06186E+02	1.78158E-01
3.90953E+04	9.60536E-04	5.55924E+02	5.33985E-01
4.08329E+04	9.74940E-03	3.39030E+02	3.30534E+00
4.25705E+04	7.53436E-02	2.05636E+02	1.54933E+01
4.43080E+04	2.81424E-01	1.24104E+02	3.49259E+01
4.60456E+04	4.79899E-01	7.45540E+01	3.57784E+01
4.77832E+04	3.70303E-01	4.45962E+01	1.65141E+01
4.95207E+04	1.34523E-01	2.65706E+01	3.57434E+00
5.12583E+04	3.33366E-02	1.57724E+01	5.25799E-01
5.29959E+04	2.20821E-02	9.33036E+00	2.06034E-01
5.47335E+04	3.55040E-02	5.50170E+00	1.95332E-01
5.64710E+04	7.41060E-02	3.23431E+00	2.39682E-01
5.82086E+04	1.61364E-01	1.89597E+00	3.05941E-01
5.99462E+04	3.06461E-01	1.10646E+00	3.39700E-01
6.16837E+04	5.21349E-01	6.46422E-01	3.37011E-01
6.34213E+04	9.56352E-01	3.76076E-01	3.59661E-01
6.51589E+04	2.05790E+00	2.18302E-01	4.49242E-01
6.68964E+04	2.26297E+00	1.26448E-01	2.86149E-01

J TOTAL = 5.71851E+07

PLANCK MEAN OPACITY = 1.72782E-02 MEAN-SQUARED PLANCK MEAN OPACITY = 5.46304E-04
ROSSELAND MEAN-FREE-PATH = 9.08678E+02 1/ROSSELAND MEAN-FREE-PATH = 1.10050E-03
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 5.13111E+06 I PRIME = 1.26428E+07

TEMPERATURE = 4.00000E+03 C/H MASS RATIO = 1.00000E-02 PRESSURE = 1.00000E+02

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	8.81307E-03	3.63754E+05	3.20579E+03
9.55663E+03	4.15104E-02	3.45236E+05	1.43309E+04
1.12942E+04	8.72491E-02	3.00388E+05	2.62086E+04
1.30318E+04	8.15601E-02	2.45004E+05	1.99826E+04
1.47693E+04	3.40151E-02	1.90082E+05	6.46567E+03
1.65069E+04	6.38675E-03	1.41717E+05	9.05113E+02
1.82445E+04	7.51396E-04	1.02295E+05	7.68638E+01
1.99821E+04	7.90275E-04	7.18885E+04	5.68116E+01
2.17196E+04	1.01018E-03	4.93980E+04	4.99011E+01
2.34572E+04	3.70375E-03	3.33016E+04	1.23341E+02
2.51948E+04	2.98451E-03	2.20847E+04	6.59119E+01
2.69323E+04	1.09608E-03	1.44386E+04	1.58258E+01
2.86699E+04	2.55283E-04	9.32257E+03	2.37990E+00
3.04075E+04	1.50396E-04	5.95330E+03	8.95353E-01
3.21450E+04	8.90170E-04	3.76462E+03	3.35115E+00
3.38826E+04	7.65440E-05	2.35980E+03	1.80628E-01
3.56202E+04	1.54381E-04	1.46757E+03	2.26564E-01
3.73578E+04	4.13300E-04	9.06186E+02	3.74527E-01
3.90953E+04	1.76470E-03	5.55924E+02	9.81039E-01
4.08329E+04	1.51991E-02	3.39030E+02	5.15296E+00
4.25705E+04	1.12820E-01	2.05636E+02	2.31998E+01
4.43080E+04	4.17458E-01	1.24104E+02	5.18084E+01
4.60456E+04	7.11480E-01	7.45540E+01	5.30436E+01
4.77832E+04	5.51252E-01	4.45962E+01	2.45837E+01
4.95207E+04	2.04994E-01	2.65706E+01	5.44681E+00
5.12583E+04	5.72567E-02	1.57724E+01	9.03077E-01
5.29959E+04	4.19587E-02	9.33036E+00	3.91490E-01
5.47335E+04	6.42269E-02	5.50170E+00	3.53357E-01
5.64710E+04	1.28363E-01	3.23431E+00	4.15167E-01
5.82086E+04	2.62160E-01	1.89597E+00	4.97049E-01
5.99462E+04	4.60014E-01	1.10846E+00	5.09909E-01
6.16837E+04	7.41336E-01	6.46422E-01	4.79215E-01
6.34213E+04	1.34660E+00	3.76076E-01	5.06424E-01
6.51589E+04	3.13784E+00	2.18302E-01	6.84997E-01
6.68964E+04	3.27170E+00	1.26448E-01	4.13701E-01

J TOTAL = 1.24521E+08

PLANCK MEAN OPACITY = 3.76235E-02 MEAN-SQUARED PLANCK MEAN OPACITY = 2.54514E-03
ROSSELAND MEAN-FREE-PATH = 4.34563E+02 1/ROSSELAND MEAN-FREE-PATH = 2.30116E-03
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 1.41049E+06 I PRIME = 3.57876E+06

TEMPERATURE = 4.00000E+03 C/H MASS RATIO = 5.00000E-02 PRESSURE = 1.00000E+02

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	4.89425E-02	3.63754E+05	1.78030E+04
9.55663E+03	2.30582E-01	3.45236E+05	7.96052E+04
1.12942E+04	4.84670E-01	3.00388E+05	1.45589E+05
1.30318E+04	4.53067E-01	2.45004E+05	1.11003E+05
1.47693E+04	1.88949E-01	1.90082E+05	3.59157E+04
1.65069E+04	3.54602E-02	1.41717E+05	5.02532E+03
1.82445E+04	4.14614E-03	1.02295E+05	4.24127E+02
1.99821E+04	4.49323E-03	7.18885E+04	3.23011E+02
2.17196E+04	8.80491E-03	4.93980E+04	4.34945E+02
2.34572E+04	3.11840E-02	3.33016E+04	1.03848E+03
2.51948E+04	3.56568E-02	2.20847E+04	7.87469E+02
2.69323E+04	1.28580E-02	1.44386E+04	1.85652E+02
2.86699E+04	1.64387E-03	9.32257E+03	1.53251E+01
3.04075E+04	4.09305E-04	5.95330E+03	2.43671E+00
3.21450E+04	2.16124E-03	3.76462E+03	8.13626E+00
3.38826E+04	3.54030E-04	2.35980E+03	8.35439E-01
3.56202E+04	8.17605E-04	1.46757E+03	1.19989E+00
3.73578E+04	2.21134E-03	9.06186E+02	2.00388E+00
3.90953E+04	7.61982E-03	5.55924E+02	4.23604E+00
4.08329E+04	4.37587E-02	3.39030E+02	1.48355E+01
4.25705E+04	2.80871E-01	2.05636E+02	5.77570E+01
4.43080E+04	1.00045E+00	1.24104E+02	1.24160E+02
4.60456E+04	1.70130E+00	7.45540E+01	1.26839E+02
4.77832E+04	1.34113E+00	4.45962E+01	5.98091E+01
4.95207E+04	5.47334E-01	2.65706E+01	1.45430E+01
5.12583E+04	2.20184E-01	1.57724E+01	3.47284E+00
5.29959E+04	2.06627E-01	9.33036E+00	1.92790E+00
5.47335E+04	3.05855E-01	5.50170E+00	1.68272E+00
5.64710E+04	5.84780E-01	3.23431E+00	1.89136E+00
5.82086E+04	1.10986E+00	1.89597E+00	2.10426E+00
5.99462E+04	1.74710E+00	1.10846E+00	1.93660E+00
6.16837E+04	2.52080E+00	6.46422E-01	1.62950E+00
6.34213E+04	4.15179E+00	3.76076E-01	1.56139E+00
6.51589E+04	1.07868E+01	2.18302E-01	2.35478E+00
6.68964E+04	9.83394E+00	1.26448E-01	1.24348E+00

J TOTAL = 6.92573E+08

PLANCK MEAN OPACITY = 2.09257E-01 MEAN-SQUARED PLANCK MEAN OPACITY = 7.74989E-02
ROSSELAND MEAN-FREE-PATH = 8.35934E+01 1/ROSSELAND MEAN-FREE-PATH = 1.19627E-02
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 8.45809E+04 I PRIME = 2.21669E+05

TEMPERATURE = 4.00000E+03 C/H MASS RATIO = 5.00000E-03 PRESSURE = 5.00000E+02

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	6.75605E-03	3.63754E+05	2.45754E+03
9.55663E+03	3.19781E-02	3.45236E+05	1.10400E+04
1.12942E+04	6.72280E-02	3.00388E+05	2.01945E+04
1.30318E+04	6.28485E-02	2.45004E+05	1.53981E+04
1.47693E+04	2.62126E-02	1.90082E+05	4.98254E+03
1.65069E+04	4.91185E-03	1.41717E+05	6.96095E+02
1.82445E+04	5.06447E-04	1.02295E+05	5.18068E+01
1.99821E+04	3.30643E-04	7.18885E+04	2.37694E+01
2.17196E+04	3.76815E-04	4.93980E+04	1.86139E+01
2.34572E+04	2.58950E-03	3.33016E+04	8.62345E+01
2.51948E+04	1.07069E-03	2.20847E+04	2.36459E+01
2.69323E+04	5.17112E-04	1.44386E+04	7.46636E+00
2.86699E+04	3.63204E-04	9.32257E+03	3.38599E+00
3.04075E+04	2.96764E-04	5.95330E+03	1.76672E+00
3.21450E+04	1.24848E-03	3.76462E+03	4.70006E+00
3.38826E+04	1.06687E-04	2.35980E+03	2.51759E-01
3.56202E+04	1.49221E-04	1.46757E+03	2.18992E-01
3.73578E+04	4.94099E-04	9.06186E+02	4.47746E-01
3.90953E+04	6.06846E-03	5.55924E+02	3.37360E+00
4.08329E+04	9.55409E-02	3.39030E+02	3.23912E+01
4.25705E+04	7.93777E-01	2.05036E+02	1.63229E+02
4.43080E+04	3.01436E+00	1.24104E+02	3.74095E+02
4.60456E+04	5.14411E+00	7.45540E+01	3.83514E+02
4.77832E+04	3.93776E+00	4.45962E+01	1.75609E+02
4.95207E+04	1.36252E+00	2.65706E+01	3.62030E+01
5.12583E+04	2.36454E-01	1.57724E+01	3.72945E+00
5.29959E+04	6.76966E-02	9.33036E+00	6.31633E-01
5.47335E+04	1.11764E-01	5.50170E+00	6.14891E-01
5.64710E+04	2.66735E-01	3.23431E+00	8.62704E-01
5.82086E+04	6.33122E-01	1.89597E+00	1.20038E+00
5.99462E+04	1.28017E+00	1.10846E+00	1.41902E+00
6.16837E+04	2.44333E+00	6.46422E-01	1.57942E+00
6.34213E+04	5.68836E+00	3.76076E-01	2.13926E+00
6.51589E+04	1.35740E+01	2.18302E-01	2.96324E+00
6.68964E+04	1.62983E+01	1.26448E-01	2.06089E+00

J TOTAL = 9.76110E+07

PLANCK MEAN OPACITY = 2.94927E-02 MEAN-SQUARED PLANCK MEAN OPACITY = 3.62091E-03
ROSSELAND MEAN-FREE-PATH = 6.48103E+02 1/ROSSELAND MEAN-FREE-PATH = 1.54297E-03
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 1.74347E+06 I PRIME = 3.42881E+06

TEMPERATURE = 4.00000E+03 C/H MASS RATIO = 1.00000E-02 PRESSURE = 5.00000E+02

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	1.72892E-02	3.63754E+05	6.28902E+03
9.55663E+03	8.18927E-02	3.45236E+05	2.82723E+04
1.12942E+04	1.72182E-01	3.00388E+05	5.17215E+04
1.30318E+04	1.60966E-01	2.45004E+05	3.94375E+04
1.47693E+04	6.71298E-02	1.90082E+05	1.27602E+04
1.65069E+04	1.25655E-02	1.41717E+05	1.78075E+03
1.82445E+04	1.26886E-03	1.02295E+05	1.29797E+02
1.99821E+04	7.82010E-04	7.18885E+04	5.62175E+01
2.17196E+04	9.78841E-04	4.93980E+04	4.83528E+01
2.34572E+04	5.15244E-03	3.33016E+04	1.71585E+02
2.51948E+04	2.97365E-03	2.20847E+04	6.56721E+01
2.69323E+04	1.27988E-03	1.44386E+04	1.84797E+01
2.86699E+04	6.28140E-04	9.32257E+03	5.85587E+00
3.04075E+04	4.79408E-04	5.95330E+03	2.85405E+00
3.21450E+04	2.00812E-03	3.76462E+03	7.55983E+00
3.38826E+04	2.02045E-04	2.35980E+03	4.76785E-01
3.56202E+04	3.32100E-04	1.46757E+03	4.87379E-01
3.73578E+04	1.10099E-03	9.06186E+02	9.97701E-01
3.90953E+04	1.07762E-02	5.55924E+02	5.99076E+00
4.08329E+04	1.55481E-01	3.39030E+02	5.27128E+01
4.25705E+04	1.27405E+00	2.05636E+02	2.61990E+02
4.43080E+04	4.82666E+00	1.24104E+02	5.99010E+02
4.60456E+04	8.23503E+00	7.45540E+01	6.13954E+02
4.77832E+04	6.30854E+00	4.45962E+01	2.81337E+02
4.95207E+04	2.19271E+00	2.65706E+01	5.82616E+01
5.12583E+04	3.93315E-01	1.57724E+01	6.20354E+00
5.29959E+04	1.21923E-01	9.33036E+00	1.13758E+00
5.47335E+04	1.91078E-01	5.50170E+00	1.05125E+00
5.64710E+04	4.43827E-01	3.23431E+00	1.43547E+00
5.82086E+04	9.74775E-01	1.89597E+00	1.84815E+00
5.99462E+04	1.76483E+00	1.10846E+00	1.95625E+00
6.16837E+04	3.21675E+00	6.46422E-01	2.07938E+00
6.34213E+04	7.98126E+00	3.76076E-01	3.00156E+00
6.51589E+04	2.12702E+01	2.18302E-01	4.64333E+00
6.68964E+04	2.46957E+01	1.26448E-01	3.12273E+00

J TOTAL = 2.47898E+08

PLANCK MEAN OPACITY = 7.49011E-02 MEAN-SQUARED PLANCK MEAN OPACITY = 1.52065E-02
ROSSELAND MEAN-FREE-PATH = 2.77445E+02 1/ROSSELAND MEAN-FREE-PATH = 3.60431E-03
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 3.55237E+05 I PRIME = 7.52177E+05

TEMPERATURE = 4.00000E+03 C/H MASS RATIO = 5.00000E-02 PRESSURE = 5.00000E+02

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	1.20853E-01	3.63754E+05	4.39606E+04
9.55663E+03	5.72851E-01	3.45236E+05	1.97769E+05
1.12942E+04	1.20457E+00	3.00388E+05	3.61838E+05
1.30318E+04	1.12611E+00	2.45004E+05	2.75902E+05
1.47693E+04	4.69597E-01	1.90082E+05	8.92619E+04
1.65069E+04	8.78020E-02	1.41717E+05	1.24431E+04
1.82445E+04	8.67812E-03	1.02295E+05	8.87725E+02
1.99821E+04	5.19007E-03	7.18885E+04	3.73106E+02
2.17196E+04	9.96647E-03	4.93980E+04	4.92324E+02
2.34572E+04	3.93865E-02	3.33016E+04	1.31164E+03
2.51948E+04	4.07080E-02	2.20847E+04	8.99023E+02
2.69323E+04	1.51738E-02	1.44386E+04	2.19088E+02
2.86699E+04	2.85845E-03	9.32257E+03	2.66481E+01
3.04075E+04	1.34615E-03	5.95330E+03	8.01401E+00
3.21450E+04	5.44138E-03	3.76462E+03	2.04847E+01
3.38826E+04	9.38240E-04	2.35980E+03	2.21405E+00
3.56202E+04	2.04089E-03	1.46757E+03	2.99514E+00
3.73578E+04	6.65967E-03	9.06186E+02	6.03490E+00
3.90953E+04	4.10479E-02	5.55924E+02	2.28195E+01
4.08329E+04	4.40474E-01	3.39030E+02	1.49334E+02
4.25705E+04	3.40398E+00	2.05636E+02	6.99980E+02
4.43080E+04	1.27608E+01	1.24104E+02	1.58367E+03
4.60456E+04	2.17514E+01	7.45540E+01	1.62165E+03
4.77832E+04	1.67232E+01	4.45962E+01	7.45792E+02
4.95207E+04	5.94382E+00	2.65706E+01	1.57931E+02
5.12583E+04	1.26012E+00	1.57724E+01	1.98751E+01
5.29959E+04	6.08830E-01	9.33036E+00	5.68060E+00
5.47335E+04	9.69091E-01	5.50170E+00	5.33165E+00
5.64710E+04	2.18303E+00	3.23431E+00	7.06059E+00
5.82086E+04	4.32741E+00	1.89597E+00	8.20466E+00
5.99462E+04	6.44091E+00	1.10846E+00	7.13952E+00
6.16837E+04	9.55345E+00	6.46422E-01	6.17556E+00
6.34213E+04	2.20978E+01	3.76076E-01	8.31047E+00
6.51589E+04	7.17117E+01	2.18302E-01	1.56548E+01
6.68964E+04	7.34233E+01	1.26448E-01	9.28423E+00

J TOTAL = 1.72106E+09

PLANCK MEAN OPACITY = 5.20009E-01 MEAN-SQUARED PLANCK MEAN OPACITY = 5.15441E-01
ROSSELAND MEAN-FREE-PATH = 4.35052E+01 1/ROSSELAND MEAN-FREE-PATH = 2.29858E-02
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 1.32230E+04 I PRIME = 3.18240E+04

TEMPERATURE = 4.00000E+03 C/H MASS RATIO = 5.00000E-03 PRESSURE = 1.00000E+03

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	6.05185E-03	3.63754E+05	2.20138E+03
9.55663E+03	2.86419E-02	3.45236E+05	9.88822E+03
1.12942E+04	6.02065E-02	3.00388E+05	1.80853E+04
1.30318E+04	5.62844E-02	2.45004E+05	1.37899E+04
1.47693E+04	2.34783E-02	1.90082E+05	4.46280E+03
1.65069E+04	4.40463E-03	1.41717E+05	6.24211E+02
1.82445E+04	4.54923E-04	1.02295E+05	4.65361E+01
1.99821E+04	2.77071E-04	7.18885E+04	1.99182E+01
2.17196E+04	3.38996E-04	4.93980E+04	1.67457E+01
2.34572E+04	2.74889E-03	3.33016E+04	9.15427E+01
2.51948E+04	1.00447E-03	2.20847E+04	2.21835E+01
2.69323E+04	5.95690E-04	1.44386E+04	8.60093E+00
2.86699E+04	5.14310E-04	9.32257E+03	4.79469E+00
3.04075E+04	4.23406E-04	5.95330E+03	2.52066E+00
3.21450E+04	1.46774E-03	3.76462E+03	5.52547E+00
3.38826E+04	1.47144E-04	2.35980E+03	3.47229E-01
3.56202E+04	1.72608E-04	1.46757E+03	2.53313E-01
3.73578E+04	6.76650E-04	9.06186E+02	6.13171E-01
3.90953E+04	1.25923E-02	5.55924E+02	7.00034E+00
4.08329E+04	2.17243E-01	3.39030E+02	7.36519E+01
4.25705E+04	1.82741E+00	2.05636E+02	3.75782E+02
4.43080E+04	6.95467E+00	1.24104E+02	8.63106E+02
4.60456E+04	1.18703E+01	7.45540E+01	8.84979E+02
4.77832E+04	9.07841E+00	4.45962E+01	4.04862E+02
4.95207E+04	3.12326E+00	2.65706E+01	8.29868E+01
5.12583E+04	5.13847E-01	1.57724E+01	8.10462E+00
5.29959E+04	1.11368E-01	9.33036E+00	1.03911E+00
5.47335E+04	1.82431E-01	5.50170E+00	1.00368E+00
5.64710E+04	4.52965E-01	3.23431E+00	1.46503E+00
5.82086E+04	1.11969E+00	1.89597E+00	2.12290E+00
5.99462E+04	2.37143E+00	1.10846E+00	2.62865E+00
6.16837E+04	4.77614E+00	6.46422E-01	3.08740E+00
6.34213E+04	1.18430E+01	3.76076E-01	4.45387E+00
6.51589E+04	2.81406E+01	2.18302E-01	6.14315E+00
6.68964E+04	3.48551E+01	1.26448E-01	4.40736E+00

J TOTAL = 9.03506E+07

PLANCK MEAN OPACITY = 2.72990E-02 MEAN-SQUARED PLANCK MEAN OPACITY = 1.25066E-02
ROSSELAND MEAN-FREE-PATH = 6.85870E+02 1/ROSSELAND MEAN-FREE-PATH = 1.45800E-03
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 1.85330E+06 I PRIME = 3.26655E+06

TEMPERATURE = 4.00000E+03 C/H MASS RATIO = 1.00000E-02 PRESSURE = 1.00000E+03

OMEGA	TOTAL MU	B(W,T)	
7.81906E+03	1.75590E-02	3.63754E+05	6.38716E+03
9.55663E+03	8.32205E-02	3.45236E+05	2.87308E+04
1.12942E+04	1.74970E-01	3.00388E+05	5.25588E+04
1.30318E+04	1.63574E-01	2.45004E+05	4.00763E+04
1.47693E+04	6.82217E-02	1.90082E+05	1.29677E+04
1.65069E+04	1.27724E-02	1.41717E+05	1.81008E+03
1.82445E+04	1.26608E-03	1.02295E+05	1.29513E+02
1.99821E+04	6.73844E-04	7.18885E+04	4.84416E+01
2.17196E+04	8.43715E-04	4.93980E+04	4.16778E+01
2.34572E+04	5.34125E-03	3.33016E+04	1.77872E+02
2.51948E+04	2.52510E-03	2.20847E+04	5.57659E+01
2.69323E+04	1.30676E-03	1.44386E+04	1.88678E+01
2.86699E+04	9.06405E-04	9.32257E+03	8.45002E+00
3.04075E+04	7.24108E-04	5.95330E+03	4.31083E+00
3.21450E+04	2.50955E-03	3.76462E+03	9.44749E+00
3.38826E+04	2.78835E-04	2.35980E+03	6.57994E-01
3.56202E+04	3.88224E-04	1.46757E+03	5.69744E-01
3.73578E+04	1.51678E-03	9.06186E+02	1.37448E+00
3.90953E+04	2.28592E-02	5.55924E+02	1.27080E+01
4.08329E+04	3.73672E-01	3.39030E+02	1.26686E+02
4.25705E+04	3.11841E+00	2.05636E+02	6.41257E+02
4.43080E+04	1.18525E+01	1.24104E+02	1.47095E+03
4.60456E+04	2.02271E+01	7.45540E+01	1.50801E+03
4.77832E+04	1.54741E+01	4.45962E+01	6.90085E+02
4.95207E+04	5.33238E+00	2.65706E+01	1.41684E+02
5.12583E+04	8.85837E-01	1.57724E+01	1.39718E+01
5.29959E+04	1.89997E-01	9.33036E+00	1.77274E+00
5.47335E+04	2.92717E-01	5.50170E+00	1.61044E+00
5.64710E+04	7.19546E-01	3.23431E+00	2.32723E+00
5.82086E+04	1.64094E+00	1.89597E+00	3.11118E+00
5.99462E+04	3.10747E+00	1.10846E+00	3.44452E+00
6.16837E+04	6.15236E+00	6.46422E-01	3.97702E+00
6.34213E+04	1.70187E+01	3.76076E-01	6.40033E+00
6.51589E+04	4.52140E+01	2.18302E-01	9.87029E+00
6.68964E+04	5.48762E+01	1.26448E-01	6.93898E+00

J TOTAL = 2.56591E+08

PLANCK MEAN OPACITY = 7.75277E-02 MEAN-SQUARED PLANCK MEAN OPACITY = 4.28259E-02
ROSSELAND MEAN-FREE-PATH = 2.80476E+02 1/ROSSELAND MEAN-FREE-PATH = 3.56537E-03
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 3.29169E+05 I PRIME = 6.20266E+05

TEMPERATURE = 4.00000E+03 C/H MASS RATIO = 5.00000E-02 PRESSURE = 1.00000E+03

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	1.50501E-01	3.63754E+05	5.47454E+04
9.55663E+03	7.14242E-01	3.45236E+05	2.46582E+05
1.12942E+04	1.50197E+00	3.00388E+05	4.51175E+05
1.30318E+04	1.40417E+00	2.45004E+05	3.44027E+05
1.47693E+04	5.85547E-01	1.90082E+05	1.11302E+05
1.65069E+04	1.09416E-01	1.41717E+05	1.55061E+04
1.82445E+04	1.04233E-02	1.02295E+05	1.06625E+03
1.99821E+04	4.89785E-03	7.18885E+04	3.52099E+02
2.17196E+04	8.83736E-03	4.93980E+04	4.36548E+02
2.34572E+04	3.73356E-02	3.33016E+04	1.24334E+03
2.51948E+04	3.50125E-02	2.20847E+04	7.73238E+02
2.69323E+04	1.37379E-02	1.44386E+04	1.98356E+02
2.86699E+04	3.66187E-03	9.32257E+03	3.41380E+01
3.04075E+04	2.19736E-03	5.95330E+03	1.30815E+01
3.21450E+04	7.50641E-03	3.76462E+03	2.82588E+01
3.38826E+04	1.32073E-03	2.35980E+03	3.11666E+00
3.56202E+04	2.66113E-03	1.46757E+03	3.90538E+00
3.73578E+04	9.86246E-03	9.06186E+02	8.93722E+00
3.90953E+04	8.67282E-02	5.55924E+02	4.82143E+01
4.08329E+04	1.13972E+00	3.39030E+02	3.86399E+02
4.25705E+04	9.16463E+00	2.05636E+02	1.88458E+03
4.43080E+04	3.46185E+01	1.24104E+02	4.29631E+03
4.60456E+04	5.90413E+01	7.45540E+01	4.40176E+03
4.77832E+04	4.52446E+01	4.45962E+01	2.01774E+03
4.95207E+04	1.57612E+01	2.65706E+01	4.18783E+02
5.12583E+04	2.87221E+00	1.57724E+01	4.53017E+01
5.29959E+04	9.39994E-01	9.33036E+00	8.77048E+00
5.47335E+04	1.56098E+00	5.50170E+00	8.58806E+00
5.64710E+04	3.79538E+00	3.23431E+00	1.22754E+01
5.82086E+04	7.64704E+00	1.89597E+00	1.44986E+01
5.99462E+04	1.13117E+01	1.10846E+00	1.25387E+01
6.16837E+04	1.77166E+01	6.46422E-01	1.14524E+01
6.34213E+04	4.79887E+01	3.76076E-01	1.80474E+01
6.51589E+04	1.56281E+02	2.18302E-01	3.41165E+01
6.68964E+04	1.70502E+02	1.26448E-01	2.15597E+01

J TOTAL = 2.15657E+09

PLANCK MEAN OPACITY = 6.51595E-01 MEAN-SQUARED PLANCK MEAN OPACITY = 1.02206E+00
ROSSELAND MEAN-FREE-PATH = 3.85474E+01 1/ROSSELAND MEAN-FREE-PATH = 2.59421E-02
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 8.23921E+03 I PRIME = 1.81369E+04

TEMPERATURE = 5.00000E+03 C/H MASS RATIO = 5.00000E-03 PRESSURE = 1.00000E+02

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	4.00286E-03	6.70766E+05	2.68498E+03
9.55663E+03	1.38846E-02	7.09896E+05	9.85660E+03
1.12942E+04	2.59487E-02	6.92124E+05	1.79597E+04
1.30318E+04	2.47311E-02	6.34807E+05	1.56995E+04
1.47693E+04	1.20655E-02	5.55228E+05	6.69911E+03
1.65069E+04	3.21370E-03	4.67491E+05	1.50237E+03
1.82445E+04	1.18950E-03	3.81535E+05	4.53834E+02
1.99821E+04	2.25023E-03	3.03398E+05	6.82715E+02
2.17196E+04	2.13947E-03	2.36024E+05	5.04967E+02
2.34572E+04	6.69830E-03	1.80198E+05	1.20702E+03
2.51948E+04	1.85299E-03	1.35365E+05	2.50830E+02
2.69323E+04	7.47030E-04	1.00260E+05	7.48975E+01
2.86699E+04	4.49986E-04	7.33441E+04	3.30039E+01
3.04075E+04	5.10152E-04	5.30684E+04	2.70730E+01
3.21450E+04	3.04486E-03	3.80245E+04	1.15779E+02
3.38826E+04	1.82407E-04	2.70078E+04	4.92641E+00
3.56202E+04	2.80721E-04	1.90322E+04	5.34274E+00
3.73578E+04	4.96184E-04	1.33165E+04	6.60744E+00
3.90953E+04	1.14466E-03	9.25704E+03	1.05961E+01
4.08329E+04	4.84334E-03	6.39704E+03	3.09830E+01
4.25705E+04	2.44982E-02	4.39669E+03	1.07711E+02
4.43080E+04	6.43820E-02	3.00677E+03	1.93582E+02
4.60456E+04	1.00670E-01	2.04677E+03	2.06049E+02
4.77832E+04	8.59932E-02	1.38734E+03	1.19302E+02
4.95207E+04	4.91930E-02	9.36639E+02	4.60761E+01
5.12583E+04	3.84605E-02	6.30024E+02	2.42310E+01
5.29959E+04	5.97662E-02	4.22322E+02	2.52406E+01
5.47335E+04	1.15682E-01	2.82182E+02	3.26432E+01
5.64710E+04	2.33761E-01	1.87975E+02	4.39412E+01
5.82086E+04	4.95300E-01	1.24864E+02	6.18452E+01
5.99462E+04	9.32630E-01	8.27206E+01	7.71477E+01
6.16837E+04	1.30102E+00	5.46631E+01	7.11180E+01
6.34213E+04	1.70179E+00	3.60364E+01	6.13262E+01
6.51589E+04	2.21894E+00	2.37033E+01	5.25963E+01
6.68964E+04	2.20617E+00	1.55579E+01	3.43234E+01

J TOTAL = 1.02461E+08

PLANCK MEAN OPACITY = 1.10838E-02 MEAN-SQUARED PLANCK MEAN OPACITY = 3.11386E-04
ROSSELAND MEAN-FREE-PATH = 4.82550E+02 1/ROSSELAND MEAN-FREE-PATH = 2.07232E-03
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 8.41686E+05 I PRIME = 1.76965E+06

TEMPERATURE = 5.00000E+03 C/H MASS RATIO = 1.00000E-02 PRESSURE = 1.00000E+02

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	9.95429E-03	6.70766E+05	6.67700E+03
9.55663E+03	3.45417E-02	7.09896E+05	2.45210E+04
1.12942E+04	6.45587E-02	6.92124E+05	4.46826E+04
1.30318E+04	6.15278E-02	6.34807E+05	3.90583E+04
1.47693E+04	3.00143E-02	5.55228E+05	1.66648E+04
1.65069E+04	7.97775E-03	4.67491E+05	3.72952E+03
1.82445E+04	2.93691E-03	3.81535E+05	1.12053E+03
1.99821E+04	5.54678E-03	3.03398E+05	1.68288E+03
2.17196E+04	5.55994E-03	2.36024E+05	1.31228E+03
2.34572E+04	1.27675E-02	1.80198E+05	2.30067E+03
2.51948E+04	5.14201E-03	1.35365E+05	6.96049E+02
2.69323E+04	2.15234E-03	1.00260E+05	2.15794E+02
2.86699E+04	8.85716E-04	7.33441E+04	6.49620E+01
3.04075E+04	8.30288E-04	5.30684E+04	4.40621E+01
3.21450E+04	4.82291E-03	3.80245E+04	1.83388E+02
3.38826E+04	3.35021E-04	2.70078E+04	9.04816E+00
3.56202E+04	5.28903E-04	1.90322E+04	1.00662E+01
3.73578E+04	9.43339E-04	1.33165E+04	1.25620E+01
3.90953E+04	2.11792E-03	9.25704E+03	1.96056E+01
4.08329E+04	8.21774E-03	6.39704E+03	5.25692E+01
4.25705E+04	4.15685E-02	4.39669E+03	1.82764E+02
4.43080E+04	1.02896E-01	3.00677E+03	3.09384E+02
4.60456E+04	1.60427E-01	2.04677E+03	3.28357E+02
4.77832E+04	1.37236E-01	1.38734E+03	1.90393E+02
4.95207E+04	7.75712E-02	9.36639E+02	7.26563E+01
5.12583E+04	5.60551E-02	6.30024E+02	3.53160E+01
5.29959E+04	7.88078E-02	4.22322E+02	3.32823E+01
5.47335E+04	1.43521E-01	2.82182E+02	4.04989E+01
5.64710E+04	2.80227E-01	1.87975E+02	5.26757E+01
5.82086E+04	5.73800E-01	1.24864E+02	7.16470E+01
5.99462E+04	1.05531E+00	8.27206E+01	8.72960E+01
6.16837E+04	1.47747E+00	5.46631E+01	8.07630E+01
6.34213E+04	1.95027E+00	3.60364E+01	7.02806E+01
6.51589E+04	2.59989E+00	2.37033E+01	6.16262E+01
6.68964E+04	2.56707E+00	1.55579E+01	3.99382E+01

J TOTAL = 2.51452E+08

PLANCK MEAN OPACITY = 2.72011E-02 MEAN-SQUARED PLANCK MEAN OPACITY = 1.42617E-03
ROSSELAND MEAN-FREE-PATH = 2.21294E+02 1/ROSSELAND MEAN-FREE-PATH = 4.51887E-03
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 2.22715E+05 I PRIME = 4.87230E+05

TEMPERATURE = 5.00000E+03 C/H MASS RATIO = 5.00000E-02 PRESSURE = 1.00000E+02

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	6.64386E-02	6.70766E+05	4.45647E+04
9.55663E+03	2.30597E-01	7.09896E+05	1.63700E+05
1.12942E+04	4.31009E-01	6.92124E+05	2.98311E+05
1.30318E+04	4.10762E-01	6.34807E+05	2.60754E+05
1.47693E+04	2.00356E-01	5.55228E+05	1.11243E+05
1.65069E+04	5.31456E-02	4.67491E+05	2.48451E+04
1.82445E+04	1.95105E-02	3.81535E+05	7.44395E+03
1.99821E+04	3.74721E-02	3.03398E+05	1.13690E+04
2.17196E+04	4.57664E-02	2.36024E+05	1.08020E+04
2.34572E+04	8.15033E-02	1.80198E+05	1.46868E+04
2.51948E+04	6.74340E-02	1.35365E+05	9.12821E+03
2.69323E+04	2.93410E-02	1.00260E+05	2.94174E+03
2.86699E+04	6.32341E-03	7.33441E+04	4.63785E+02
3.04075E+04	2.64405E-03	5.30684E+04	1.40316E+02
3.21450E+04	1.28916E-02	3.80245E+04	4.90196E+02
3.38826E+04	1.68461E-03	2.70078E+04	4.54974E+01
3.56202E+04	2.84357E-03	1.90322E+04	5.41194E+01
3.73578E+04	5.13331E-03	1.33165E+04	6.83578E+01
3.90953E+04	1.04839E-02	9.25704E+03	9.70503E+01
4.08329E+04	3.02173E-02	6.39704E+03	1.93302E+02
4.25705E+04	1.44280E-01	4.39669E+03	6.34352E+02
4.43080E+04	2.87944E-01	3.00677E+03	8.65781E+02
4.60456E+04	4.46193E-01	2.04677E+03	9.13256E+02
4.77832E+04	3.98517E-01	1.38734E+03	5.52878E+02
4.95207E+04	2.54560E-01	9.36639E+02	2.38431E+02
5.12583E+04	2.03638E-01	6.30024E+02	1.28297E+02
5.29959E+04	2.57509E-01	4.22322E+02	1.08752E+02
5.47335E+04	4.07772E-01	2.82182E+02	1.15066E+02
5.64710E+04	7.21511E-01	1.87975E+02	1.35626E+02
5.82086E+04	1.31923E+00	1.24864E+02	1.64724E+02
5.99462E+04	2.21696E+00	8.27206E+01	1.83388E+02
6.16837E+04	3.11700E+00	5.46631E+01	1.70385E+02
6.34213E+04	4.13302E+00	3.60364E+01	1.48939E+02
6.51589E+04	5.77606E+00	2.37033E+01	1.36912E+02
6.68964E+04	5.43076E+00	1.55579E+01	8.44911E+01

J TOTAL = 1.67836E+09

PLANCK MEAN OPACITY = 1.81559E-01 MEAN-SQUARED PLANCK MEAN OPACITY = 5.77482E-02
ROSSELAND MEAN-FREE-PATH = 3.79519E+01 1/ROSSELAND MEAN-FREE-PATH = 2.63491E-02
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 9.11934E+03 L PRIME = 2.03516E+04

TEMPERATURE = 5.00000E+03 C/H MASS RATIO = 5.00000E-03 PRESSURE = 5.00000E+02

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	1.86718E-02	6.70766E+05	1.25244E+04
9.55663E+03	6.76385E-02	7.09696E+05	4.80163E+04
1.12942E+04	1.26835E-01	6.92124E+05	8.77857E+04
1.30318E+04	1.20977E-01	6.34807E+05	7.67970E+04
1.47693E+04	5.89420E-02	5.55228E+05	3.27263E+04
1.65069E+04	1.51232E-02	4.67491E+05	7.06996E+03
1.82445E+04	3.48888E-03	3.81535E+05	1.33113E+03
1.99821E+04	4.56769E-03	3.03398E+05	1.38583E+03
2.17196E+04	4.52591E-03	2.36024E+05	1.06822E+03
2.34572E+04	2.29044E-02	1.80198E+05	4.12733E+03
2.51948E+04	6.13642E-03	1.35365E+05	8.30656E+02
2.69323E+04	2.80398E-03	1.00260E+05	2.81128E+02
2.86699E+04	2.06056E-03	7.33441E+04	1.51130E+02
3.04075E+04	2.28383E-03	5.30684E+04	1.21199E+02
3.21450E+04	1.13432E-02	3.80245E+04	4.31320E+02
3.38826E+04	9.94724E-04	2.70078E+04	2.68653E+01
3.56202E+04	1.47604E-03	1.90322E+04	2.80923E+01
3.73578E+04	2.91470E-03	1.33165E+04	3.88137E+01
3.90953E+04	1.21480E-02	9.25704E+03	1.12455E+02
4.08329E+04	9.37730E-02	6.39704E+03	5.99869E+02
4.25705E+04	5.22974E-01	4.39669E+03	2.29935E+03
4.43080E+04	1.55712E+00	3.00677E+03	4.68189E+03
4.60456E+04	2.42995E+00	2.04677E+03	4.97356E+03
4.77832E+04	1.97717E+00	1.38734E+03	2.74300E+03
4.95207E+04	8.98798E-01	9.36639E+02	8.41849E+02
5.12583E+04	3.70602E-01	6.30024E+02	2.33488E+02
5.29959E+04	4.07865E-01	4.22322E+02	1.72250E+02
5.47335E+04	7.79815E-01	2.82182E+02	2.20049E+02
5.64710E+04	1.59427E+00	1.87975E+02	2.99682E+02
5.82086E+04	3.40445E+00	1.24864E+02	4.25093E+02
5.99462E+04	6.44592E+00	8.27206E+01	5.33210E+02
6.16837E+04	9.16388E+00	5.46631E+01	5.00926E+02
6.34213E+04	1.28196E+01	3.60364E+01	4.61972E+02
6.51589E+04	1.83452E+01	2.37033E+01	4.34843E+02
6.68964E+04	1.89518E+01	1.55579E+01	2.94851E+02

J TOTAL = 5.11836E+08

PLANCK MEAN OPACITY = 5.53684E-02 MEAN-SQUARED PLANCK MEAN OPACITY = 1.55350E-02
ROSSELAND MEAN-FREE-PATH = 1.30727E+02 1/ROSSELAND MEAN-FREE-PATH = 7.64955E-03
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 4.50844E+04 I PRIME = 8.29072E+04

TEMPERATURE = 5.00000E+03 C/H MASS RATIO = 1.00000E-02 PRESSURE = 5.00000E+02

OMEGA	TOTAL MU	E(W,T)	J
7.81906E+03	4.52000E-02	6.70766E+05	3.03186E+04
9.55663E+03	1.63860E-01	7.09896E+05	1.16323E+05
1.12942E+04	3.07309E-01	6.92124E+05	2.12696E+05
1.30318E+04	2.93110E-01	6.34807E+05	1.86068E+05
1.47693E+04	1.42782E-01	5.55228E+05	7.92767E+04
1.65069E+04	3.65433E-02	4.67491E+05	1.70836E+04
1.82445E+04	8.29993E-03	3.81535E+05	3.16671E+03
1.99821E+04	1.07164E-02	3.03398E+05	3.25134E+03
2.17196E+04	1.11958E-02	2.36024E+05	2.64248E+03
2.34572E+04	4.06051E-02	1.80198E+05	7.31697E+03
2.51948E+04	1.47689E-02	1.35365E+05	1.99919E+03
2.69323E+04	6.64168E-03	1.00260E+05	6.65897E+02
2.86699E+04	3.58141E-03	7.33441E+04	2.62676E+02
3.04075E+04	3.56556E-03	5.30684E+04	1.89219E+02
3.21450E+04	1.76439E-02	3.80245E+04	6.70898E+02
3.38826E+04	1.56680E-03	2.70078E+04	4.23157E+01
3.56202E+04	2.40112E-03	1.90322E+04	4.56987E+01
3.73578E+04	4.88533E-03	1.33165E+04	6.50555E+01
3.90953E+04	1.98921E-02	9.25704E+03	1.84142E+02
4.08329E+04	1.48033E-01	6.39704E+03	9.46974E+02
4.25705E+04	8.20577E-01	4.39669E+03	3.60782E+03
4.43080E+04	2.42670E+00	3.00077E+03	7.29653E+03
4.60456E+04	3.78412E+00	2.04677E+03	7.74524E+03
4.77832E+04	3.07638E+00	1.38734E+03	4.26799E+03
4.95207E+04	1.38438E+00	9.36039E+02	1.29667E+03
5.12583E+04	5.27450E-01	6.30024E+02	3.32306E+02
5.29959E+04	5.06165E-01	4.22322E+02	2.13765E+02
5.47335E+04	9.16603E-01	2.82182E+02	2.58648E+02
5.64710E+04	1.83218E+00	1.87975E+02	3.44405E+02
5.82086E+04	3.81067E+00	1.24864E+02	4.75816E+02
5.99462E+04	7.07324E+00	8.27206E+01	5.85103E+02
6.16837E+04	1.01525E+01	5.46631E+01	5.54966E+02
6.34213E+04	1.47280E+01	3.60364E+01	5.30743E+02
6.51589E+04	2.24220E+01	2.37033E+01	5.31476E+02
6.68964E+04	2.32337E+01	1.55579E+01	3.61467E+02

J TOTAL = 1.20174E+09

PLANCK MEAN OPACITY = 1.29999E-01 MEAN-SQUARED PLANCK MEAN OPACITY = 4.86124E-02
ROSSELAND MEAN-FREE-PATH = 6.30275E+01 1/ROSSELAND MEAN-FREE-PATH = 1.58661E-02
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 1.32049E+04 1 PRIME = 2.66488E+04

TEMPERATURE = 5.00000E+03 C/H MASS RATIO = 5.00000E-02 PRESSURE = 5.00000E+02

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	2.90891E-01	6.70766E+05	1.95120E+05
9.55663E+03	1.05535E+00	7.09896E+05	7.49188E+05
1.12942E+04	1.97952E+00	6.92124E+05	1.37007E+06
1.30318E+04	1.88803E+00	6.34807E+05	1.19853E+06
1.47693E+04	9.19530E-01	5.55228E+05	5.10549E+05
1.65069E+04	2.34713E-01	4.67491E+05	1.09726E+05
1.82445E+04	5.24932E-02	3.81535E+05	2.00280E+04
1.99821E+04	6.82798E-02	3.03398E+05	2.07159E+04
2.17196E+04	8.92550E-02	2.36024E+05	2.10664E+04
2.34572E+04	2.10428E-01	1.80198E+05	3.79188E+04
2.51948E+04	1.60158E-01	1.35365E+05	2.16798E+04
2.69323E+04	7.06884E-02	1.00260E+05	7.08724E+03
2.86699E+04	1.80116E-02	7.33441E+04	1.32104E+03
3.04075E+04	1.00184E-02	5.30684E+04	5.31658E+02
3.21450E+04	4.56780E-02	3.80245E+04	1.73688E+03
3.38826E+04	6.05781E-03	2.70078E+04	1.63608E+02
3.56202E+04	1.05712E-02	1.90322E+04	2.01193E+02
3.73578E+04	2.20676E-02	1.33165E+04	2.93863E+02
3.90953E+04	7.11178E-02	9.25704E+03	6.58340E+02
4.08329E+04	4.14569E-01	6.39704E+03	2.65201E+03
4.25705E+04	2.17940E+00	4.39669E+03	9.58215E+03
4.43080E+04	6.23371E+00	3.00677E+03	1.87433E+04
4.60456E+04	9.70525E+00	2.04677E+03	1.98644E+04
4.77832E+04	7.96125E+00	1.38734E+03	1.10450E+04
4.95207E+04	3.70858E+00	9.36639E+02	3.47360E+03
5.12583E+04	1.52290E+00	6.30024E+02	9.59463E+02
5.29959E+04	1.36781E+00	4.22322E+02	5.77655E+02
5.47335E+04	2.16183E+00	2.82182E+02	6.15674E+02
5.64710E+04	4.03733E+00	1.87975E+02	7.58918E+02
5.82086E+04	7.57181E+00	1.24864E+02	9.45447E+02
5.99462E+04	1.27990E+01	8.27206E+01	1.05874E+03
6.16837E+04	1.84546E+01	5.46631E+01	1.00878E+03
6.34213E+04	2.82366E+01	3.60364E+01	1.01755E+03
6.51589E+04	4.98023E+01	2.37033E+01	1.18048E+03
6.68964E+04	4.96374E+01	1.55579E+01	7.72253E+02

J TOTAL = 7.54253E+09

PLANCK MEAN OPACITY = 8.15922E-01 MEAN-SQUARED PLANCK MEAN OPACITY = 1.30415E+00
ROSSELAND MEAN-FREE-PATH = 1.19242E+01 1/ROSSELAND MEAN-FREE-PATH = 8.38628E-02
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 7.34783E+02 I PRIME = 1.59425E+03

TEMPERATURE = 5.00000E+03 C/H MASS RATIO = 5.00000E-03 PRESSURE = 1.00000E+03

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	2.56401E-02	6.70766E+05	1.71985E+04
9.55663E+03	9.36096E-02	7.09896E+05	6.64531E+04
1.12942E+04	1.75622E-01	6.92124E+05	1.21552E+05
1.30318E+04	1.67536E-01	6.34807E+05	1.06353E+05
1.47693E+04	8.16219E-02	5.55228E+05	4.53188E+04
1.65069E+04	2.08307E-02	4.67491E+05	9.73814E+03
1.82445E+04	4.29296E-03	3.81535E+05	1.63791E+03
1.99821E+04	4.76769E-03	3.03398E+05	1.44651E+03
2.17196E+04	4.83465E-03	2.36024E+05	1.14110E+03
2.34572E+04	3.17707E-02	1.80198E+05	5.72503E+03
2.51948E+04	8.11135E-03	1.35365E+05	1.09799E+03
2.69323E+04	4.10754E-03	1.00260E+05	4.11623E+02
2.86699E+04	3.46141E-03	7.33441E+04	2.53674E+02
3.04075E+04	3.79241E-03	5.30684E+04	2.01257E+02
3.21450E+04	1.66622E-02	3.80245E+04	6.33571E+02
3.38826E+04	1.86155E-03	2.70078E+04	5.02764E+01
3.56202E+04	2.68785E-03	1.90322E+04	5.11557E+01
3.73578E+04	5.63829E-03	1.33165E+04	7.50823E+01
3.90953E+04	3.13719E-02	9.25704E+03	2.90411E+02
4.08329E+04	2.79640E-01	6.39704E+03	1.78887E+03
4.25705E+04	1.59544E+00	4.39669E+03	7.01465E+03
4.43080E+04	4.80191E+00	3.00677E+03	1.44382E+04
4.60456E+04	7.49191E+00	2.04677E+03	1.53342E+04
4.77832E+04	6.05648E+00	1.38734E+03	8.40240E+03
4.95207E+04	2.65639E+00	9.36639E+02	2.48807E+03
5.12583E+04	9.23438E-01	6.30024E+02	5.81788E+02
5.29959E+04	8.55315E-01	4.22322E+02	3.61218E+02
5.47335E+04	1.62589E+00	2.82182E+02	4.58796E+02
5.64710E+04	3.35076E+00	1.87975E+02	6.29858E+02
5.82086E+04	7.20807E+00	1.24864E+02	9.00029E+02
5.99462E+04	1.37350E+01	8.27206E+01	1.13616E+03
6.16837E+04	1.97752E+01	5.46631E+01	1.08097E+03
6.34213E+04	2.87233E+01	3.60364E+01	1.03508E+03
6.51589E+04	4.27007E+01	2.37033E+01	1.01215E+03
6.68964E+04	4.50715E+01	1.55579E+01	7.01218E+02

J TOTAL = 7.59306E+08

PLANCK MEAN OPACITY = 8.21389E-02 MEAN-SQUARED PLANCK MEAN OPACITY = 8.55411E-02
ROSSELAND MEAN-FREE-PATH = 9.68966E+01 1/ROSSELAND MEAN-FREE-PATH = 1.03203E-02
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 2.15190E+04 I PRIME = 3.48325E+04

TEMPERATURE = 5.00000E+03 C/H MASS RATIO = 1.00000E-02 PRESSURE = 1.00000E+03

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	6.61198E-02	6.70766E+05	4.43509E+04
9.55663E+03	2.41691E-01	7.09896E+05	1.71575E+05
1.12942E+04	4.53538E-01	6.92124E+05	3.13905E+05
1.30318E+04	4.32649E-01	6.34807E+05	2.74649E+05
1.47693E+04	2.10722E-01	5.55228E+05	1.16999E+05
1.65069E+04	5.35881E-02	4.67491E+05	2.50519E+04
1.82445E+04	1.07427E-02	3.81535E+05	4.09870E+03
1.99821E+04	1.15266E-02	3.03398E+05	3.49714E+03
2.17196E+04	1.21441E-02	2.36024E+05	2.86630E+03
2.34572E+04	5.62479E-02	1.80198E+05	1.01358E+04
2.51948E+04	1.84789E-02	1.35365E+05	2.50139E+03
2.69323E+04	8.95312E-03	1.00260E+05	8.97643E+02
2.86699E+04	5.90176E-03	7.33441E+04	4.32860E+02
3.04075E+04	6.01942E-03	5.30684E+04	3.19441E+02
3.21450E+04	2.66303E-02	3.80245E+04	1.01260E+03
3.38826E+04	2.79392E-03	2.70078E+04	7.54577E+01
3.56202E+04	4.10017E-03	1.90322E+04	7.80353E+01
3.73578E+04	8.99790E-03	1.33165E+04	1.19821E+02
3.90953E+04	5.10797E-02	9.25704E+03	4.72847E+02
4.08329E+04	4.51409E-01	6.39704E+03	2.88768E+03
4.25705E+04	2.57065E+00	4.39669E+03	1.13023E+04
4.43080E+04	7.71851E+00	3.00677E+03	2.32078E+04
4.60456E+04	1.20360E+01	2.04677E+03	2.46350E+04
4.77832E+04	9.71586E+00	1.38734E+03	1.34792E+04
4.95207E+04	4.21137E+00	9.36639E+02	3.94453E+03
5.12583E+04	1.33541E+00	6.30024E+02	8.41342E+02
5.29959E+04	1.02728E+00	4.22322E+02	4.33841E+02
5.47335E+04	1.84705E+00	2.82182E+02	5.21202E+02
5.64710E+04	3.74624E+00	1.87975E+02	7.04200E+02
5.82086E+04	7.88845E+00	1.24864E+02	9.84984E+02
5.99462E+04	1.47907E+01	8.27206E+01	1.22350E+03
6.16837E+04	2.16562E+01	5.46631E+01	1.18379E+03
6.34213E+04	3.33015E+01	3.60364E+01	1.20007E+03
6.51589E+04	5.35524E+01	2.37033E+01	1.26937E+03
6.68964E+04	5.71150E+01	1.55579E+01	8.88589E+02

J TOTAL = 1.84486E+09

PLANCK MEAN OPACITY = 1.99570E-01 MEAN-SQUARED PLANCK MEAN OPACITY = 2.25806E-01
ROSSELAND MEAN-FREE-PATH = 4.51355E+01 1/ROSSELAND MEAN-FREE-PATH = 2.21555E-02
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 5.57963E+03 I PRIME = 1.03465E+04

TEMPERATURE = 5.00000E+03 C/H MASS RATIO = 5.00000E-02 PRESSURE = 1.00000E+03

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	4.67942E-01	6.70766E+05	3.13879E+05
9.55663E+03	1.71258E+00	7.09896E+05	1.21575E+06
1.12942E+04	3.21441E+00	6.92124E+05	2.22477E+06
1.30318E+04	3.06631E+00	6.34807E+05	1.94651E+06
1.47693E+04	1.49301E+00	5.55228E+05	8.28960E+05
1.65069E+04	3.78312E-01	4.67491E+05	1.76857E+05
1.82445E+04	7.37592E-02	3.81535E+05	2.81417E+04
1.99821E+04	7.80523E-02	3.03398E+05	2.36809E+04
2.17196E+04	1.02586E-01	2.36024E+05	2.42129E+04
2.34572E+04	2.75680E-01	1.80198E+05	4.96772E+04
2.51948E+04	1.93460E-01	1.35365E+05	2.61878E+04
2.69323E+04	8.70868E-02	1.00260E+05	8.73135E+03
2.86699E+04	2.60795E-02	7.33441E+04	1.91278E+03
3.04075E+04	1.70245E-02	5.30684E+04	9.03463E+02
3.21450E+04	7.18462E-02	3.80245E+04	2.73192E+03
3.38826E+04	1.00263E-02	2.70078E+04	2.70788E+02
3.56202E+04	1.70745E-02	1.90322E+04	3.24966E+02
3.73578E+04	3.84996E-02	1.33165E+04	5.12681E+02
3.90953E+04	1.69227E-01	9.25704E+03	1.56654E+03
4.08329E+04	1.26360E+00	6.39704E+03	8.08330E+03
4.25705E+04	6.96344E+00	4.39669E+03	3.06160E+04
4.43080E+04	2.06027E+01	3.00677E+03	6.19477E+04
4.60456E+04	3.20942E+01	2.04677E+03	6.56895E+04
4.77832E+04	2.60046E+01	1.38734E+03	3.60772E+04
4.95207E+04	1.14248E+01	9.36639E+02	1.07009E+04
5.12583E+04	3.69484E+00	6.30024E+02	2.32784E+03
5.29959E+04	2.54952E+00	4.22322E+02	1.07672E+03
5.47335E+04	4.03608E+00	2.82182E+02	1.13891E+03
5.64710E+04	7.67880E+00	1.87975E+02	1.44342E+03
5.82086E+04	1.46392E+01	1.24864E+02	1.82791E+03
5.99462E+04	2.49533E+01	8.27206E+01	2.06415E+03
6.16837E+04	3.70975E+01	5.46631E+01	2.02787E+03
6.34213E+04	6.29871E+01	3.60364E+01	2.26983E+03
6.51589E+04	1.22043E+02	2.37033E+01	2.89284E+03
6.68964E+04	1.26545E+02	1.55579E+01	1.96877E+03

TOTAL = 1.23502E+10

PLANCK MEAN OPACITY = 1.33600E+00 MEAN-SQUARED PLANCK MEAN OPACITY = 4.18670E+00
ROSSELAND MEAN-FREE-PATH = 8.15195E+00 1/ROSSELAND MEAN-FREE-PATH = 1.22670E-01
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 2.90823E+02 I PRIME = 6.14145E+02

TEMPERATURE = 6.50000E+03 C/H MASS RATIO = 5.00000E-03 PRESSURE = 1.00000E+02

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	6.76058E-03	1.22568E+06	8.28632E+03
9.55663E+03	8.87988E-03	1.42535E+06	1.26569E+04
1.12942E+04	9.64006E-03	1.53436E+06	1.47913E+04
1.30318E+04	9.47183E-03	1.55994E+06	1.47755E+04
1.47693E+04	8.86525E-03	1.51710E+06	1.34495E+04
1.65069E+04	8.20821E-03	1.42379E+06	1.16867E+04
1.82445E+04	7.59942E-03	1.29758E+06	9.86088E+03
1.99821E+04	7.06980E-03	1.15384E+06	8.15740E+03
2.17196E+04	6.55653E-03	1.00476E+06	6.58777E+03
2.34572E+04	7.88785E-03	8.59328E+05	6.77826E+03
2.51948E+04	5.69135E-03	7.23521E+05	4.11781E+03
2.69323E+04	5.13465E-03	6.00869E+05	3.08525E+03
2.86699E+04	4.85673E-03	4.92995E+05	2.39435E+03
3.04075E+04	4.67791E-03	4.00152E+05	1.87188E+03
3.21450E+04	5.32052E-03	3.21680E+05	1.71151E+03
3.38826E+04	4.28894E-03	2.56368E+05	1.09955E+03
3.56202E+04	4.42977E-03	2.02726E+05	8.98029E+02
3.73578E+04	4.82187E-03	1.59175E+05	7.67521E+02
3.90953E+04	5.51593E-03	1.24175E+05	6.84943E+02
4.08329E+04	6.75716E-03	9.63011E+04	6.50722E+02
4.25705E+04	8.92333E-03	7.42803E+04	6.62827E+02
4.43080E+04	1.21278E-02	5.70097E+04	6.91404E+02
4.60456E+04	1.81862E-02	4.35534E+04	7.92072E+02
4.77832E+04	2.81232E-02	3.31315E+04	9.31764E+02
4.95207E+04	4.69101E-02	2.51037E+04	1.17762E+03
5.12583E+04	7.84273E-02	1.89509E+04	1.48627E+03
5.29959E+04	1.34430E-01	1.42570E+04	1.91656E+03
5.47335E+04	2.34122E-01	1.06911E+04	2.50302E+03
5.64710E+04	4.28364E-01	7.99288E+03	3.42386E+03
5.82086E+04	7.45612E-01	5.95869E+03	4.44287E+03
5.99462E+04	1.20575E+00	4.43034E+03	5.34187E+03
6.16837E+04	1.38976E+00	3.28571E+03	4.56633E+03
6.34213E+04	1.48693E+00	2.43101E+03	3.61474E+03
6.51589E+04	1.59173E+00	1.79459E+03	2.85650E+03
6.68964E+04	1.34171E+00	1.32196E+03	1.77368E+03

J TOTAL = 2.78869E+08

PLANCK MEAN OPACITY = 9.61967E-03 MEAN-SQUARED PLANCK MEAN OPACITY = 1.91339E-03
ROSSELAND MEAN-FREE-PATH = 1.45279E+02 1/ROSSELAND MEAN-FREE-PATH = 6.88333E-03
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 2.29953E+04 I PRIME = 2.67205E+04

TEMPERATURE = 6.50000E+03 C/H MASS RATIO = 1.00000E-02 PRESSURE = 1.00000E+02

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	6.99381E-03	1.22568E+06	8.57218E+03
9.55663E+03	9.28125E-03	1.42535E+06	1.32290E+04
1.12942E+04	1.02529E-02	1.53436E+06	1.57317E+04
1.30318E+04	1.00663E-02	1.55994E+06	1.57029E+04
1.47693E+04	9.24198E-03	1.51710E+06	1.40210E+04
1.65069E+04	8.45225E-03	1.42379E+06	1.20342E+04
1.82445E+04	7.93684E-03	1.29758E+06	1.02987E+04
1.99821E+04	7.71302E-03	1.15384E+06	8.89957E+03
2.17196E+04	7.21231E-03	1.00476E+06	7.24667E+03
2.34572E+04	1.00810E-02	8.59328E+05	8.66287E+03
2.51948E+04	6.01953E-03	7.23521E+05	4.35526E+03
2.69323E+04	5.27611E-03	6.00869E+05	3.17025E+03
2.86699E+04	4.99398E-03	4.92995E+05	2.46201E+03
3.04075E+04	4.91259E-03	4.00152E+05	1.96578E+03
3.21450E+04	6.36396E-03	3.21680E+05	2.04716E+03
3.38826E+04	4.34320E-03	2.56368E+05	1.11346E+03
3.56202E+04	4.48505E-03	2.02726E+05	9.09237E+02
3.73578E+04	4.88230E-03	1.59175E+05	7.77141E+02
3.90953E+04	5.58930E-03	1.24175E+05	6.94053E+02
4.08329E+04	6.88097E-03	9.63011E+04	6.62645E+02
4.25705E+04	9.84222E-03	7.42803E+04	7.31083E+02
4.43080E+04	1.26847E-02	5.70097E+04	7.23152E+02
4.60456E+04	1.89462E-02	4.35534E+04	8.25170E+02
4.77832E+04	2.88110E-02	3.31315E+04	9.54552E+02
4.95207E+04	4.73502E-02	2.51037E+04	1.18867E+03
5.12583E+04	7.87165E-02	1.89509E+04	1.49175E+03
5.29959E+04	1.34722E-01	1.42570E+04	1.92072E+03
5.47335E+04	2.34519E-01	1.06911E+04	2.50726E+03
5.64710E+04	4.28940E-01	7.99288E+03	3.42846E+03
5.82086E+04	7.46439E-01	5.95869E+03	4.44780E+03
5.99462E+04	1.20686E+00	4.43034E+03	5.34683E+03
6.16837E+04	1.39147E+00	3.28571E+03	4.57198E+03
6.34213E+04	1.48941E+00	2.43101E+03	3.62078E+03
6.51589E+04	1.59493E+00	1.79459E+03	2.86225E+03
6.68964E+04	1.34503E+00	1.32196E+03	1.77807E+03

J TOTAL = 2.93570E+08

PLANCK MEAN OPACITY = 1.01268E-02 MEAN-SQUARED PLANCK MEAN OPACITY = 1.92744E-03
ROSSELAND MEAN-FREE-PATH = 1.36665E+02 1/ROSSELAND MEAN-FREE-PATH = 7.31716E-03
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 2.05548E+04 I PRIME = 2.40598E+04

TEMPERATURE = 6.50000E+03 C/H MASS RATIO = 5.00000E-02 PRESSURE = 1.00000E+02

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	1.27045E-02	1.22568E+06	1.55717E+04
9.55663E+03	1.95078E-02	1.42535E+06	2.78054E+04
1.12942E+04	2.63920E-02	1.53436E+06	4.04948E+04
1.30318E+04	2.56631E-02	1.55994E+06	4.00329E+04
1.47693E+04	1.86820E-02	1.51710E+06	2.83426E+04
1.65069E+04	1.40462E-02	1.42379E+06	1.99988E+04
1.82445E+04	1.63105E-02	1.29758E+06	2.11643E+04
1.99821E+04	2.45323E-02	1.15384E+06	2.83063E+04
2.17196E+04	2.49792E-02	1.00476E+06	2.50982E+04
2.34572E+04	3.18312E-02	8.59328E+05	2.73535E+04
2.51948E+04	1.04847E-02	7.23521E+05	7.58590E+03
2.69323E+04	7.40254E-03	6.00869E+05	4.44796E+03
2.86699E+04	6.59049E-03	4.92995E+05	3.24908E+03
3.04075E+04	6.97773E-03	4.00152E+05	2.79216E+03
3.21450E+04	1.45037E-02	3.21680E+05	4.66555E+03
3.38826E+04	5.19494E-03	2.56368E+05	1.33182E+03
3.56202E+04	5.48731E-03	2.02726E+05	1.11242E+03
3.73578E+04	6.07388E-03	1.59175E+05	9.66809E+02
3.90953E+04	7.07622E-03	1.24175E+05	8.78693E+02
4.08329E+04	9.03679E-03	9.63011E+04	8.70253E+02
4.25705E+04	3.19258E-02	7.42803E+04	2.37146E+03
4.43080E+04	1.88356E-02	5.70097E+04	1.07381E+03
4.60456E+04	2.70181E-02	4.35534E+04	1.17673E+03
4.77832E+04	3.71605E-02	3.31315E+04	1.23118E+03
4.95207E+04	5.46091E-02	2.51037E+04	1.37089E+03
5.12583E+04	8.60797E-02	1.89509E+04	1.63129E+03
5.29959E+04	1.44318E-01	1.42570E+04	2.05753E+03
5.47335E+04	2.48814E-01	1.06911E+04	2.66009E+03
5.64710E+04	4.51145E-01	7.99288E+03	3.60595E+03
5.82086E+04	7.80301E-01	5.95869E+03	4.64958E+03
5.99462E+04	1.25514E+00	4.43034E+03	5.56071E+03
6.16837E+04	1.45695E+00	3.28571E+03	4.78712E+03
6.34213E+04	1.57045E+00	2.43101E+03	3.81777E+03
6.51589E+04	1.68673E+00	1.79459E+03	3.02698E+03
6.68964E+04	1.43174E+00	1.32196E+03	1.89271E+03

J TOTAL = 5.95956E+08

PLANCK MEAN OPACITY = 2.05577E-02 MEAN-SQUARED PLANCK MEAN OPACITY = 2.44582E-03
ROSSELAND MEAN-FREE-PATH = 7.54042E+01 1/ROSSELAND MEAN-FREE-PATH = 1.32619E-02
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 7.84201E+03 I PRIME = 1.08851E+04

TEMPERATURE = 6.50000E+03 C/H MASS RATIO = 5.00000E-03 PRESSURE = 5.00000E+02

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	7.00092E-02	1.22568E+06	8.58089E+04
9.55663E+03	8.99447E-02	1.42535E+06	1.28202E+05
1.12942E+04	9.95517E-02	1.53436E+06	1.52748E+05
1.30318E+04	9.69367E-02	1.55994E+06	1.51216E+05
1.47693E+04	8.64829E-02	1.51710E+06	1.31203E+05
1.65069E+04	7.65606E-02	1.42379E+06	1.09006E+05
1.82445E+04	6.99299E-02	1.29758E+06	9.07399E+04
1.99821E+04	6.59755E-02	1.15384E+06	7.61250E+04
2.17196E+04	6.14104E-02	1.00476E+06	6.17029E+04
2.34572E+04	8.57836E-02	8.59328E+05	7.37163E+04
2.51948E+04	5.36738E-02	7.23521E+05	3.88341E+04
2.69323E+04	4.75917E-02	6.00869E+05	2.85964E+04
2.86699E+04	4.50262E-02	4.92995E+05	2.21977E+04
3.04075E+04	4.44960E-02	4.00152E+05	1.78052E+04
3.21450E+04	5.65711E-02	3.21680E+05	1.81978E+04
3.38826E+04	4.13907E-02	2.56368E+05	1.06113E+04
3.56202E+04	4.44116E-02	2.02726E+05	9.00339E+03
3.73578E+04	5.08276E-02	1.59175E+05	8.09049E+03
3.90953E+04	6.23430E-02	1.24175E+05	7.74147E+03
4.08329E+04	8.78636E-02	9.63011E+04	8.46136E+03
4.25705E+04	1.47628E-01	7.42803E+04	1.09659E+04
4.43080E+04	2.43539E-01	5.70097E+04	1.38840E+04
4.60456E+04	3.63973E-01	4.35534E+04	1.58523E+04
4.77832E+04	4.77088E-01	3.31315E+04	1.58066E+04
4.95207E+04	6.74832E-01	2.51037E+04	1.69408E+04
5.12583E+04	1.06002E+00	1.89509E+04	2.00885E+04
5.29959E+04	1.79837E+00	1.42570E+04	2.56393E+04
5.47335E+04	3.13296E+00	1.06911E+04	3.34947E+04
5.64710E+04	5.73629E+00	7.99288E+03	4.58495E+04
5.82086E+04	9.98784E+00	5.95869E+03	5.95145E+04
5.99462E+04	1.61560E+01	4.43034E+03	7.15765E+04
6.16837E+04	1.86526E+01	3.28571E+03	6.12871E+04
6.34213E+04	2.00364E+01	2.43101E+03	4.87087E+04
6.51589E+04	2.15607E+01	1.79459E+03	3.86927E+04
6.68964E+04	1.82561E+01	1.32196E+03	2.41338E+04

J TOTAL = 3.01024E+09

PLANCK MEAN OPACITY = 1.03839E-01 MEAN-SQUARED PLANCK MEAN OPACITY = 3.42076E-01
ROSSELAND MEAN-FREE-PATH = 1.47576E+01 1/ROSSELAND MEAN-FREE-PATH = 6.77615E-02
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 2.41409E+02 I PRIME = 2.75393E+02

TEMPERATURE = 6.50000E+03 C/H MASS RATIO = 1.00000E-02 PRESSURE = 5.00000E+02

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	7.81745E-02	1.22568E+06	9.58170E+04
9.55663E+03	1.09606E-01	1.42535E+06	1.56227E+05
1.12942E+04	1.31837E-01	1.53436E+06	2.02285E+05
1.30318E+04	1.28437E-01	1.55994E+06	2.00354E+05
1.47693E+04	1.04939E-01	1.51710E+06	1.59203E+05
1.65069E+04	8.44277E-02	1.42379E+06	1.20207E+05
1.82445E+04	7.59630E-02	1.29758E+06	9.85684E+04
1.99821E+04	7.63276E-02	1.15384E+06	8.80696E+04
2.17196E+04	7.21733E-02	1.00476E+06	7.25172E+04
2.34572E+04	1.18013E-01	8.59328E+05	1.01412E+05
2.51948E+04	5.92076E-02	7.23521E+05	4.28379E+04
2.69323E+04	5.01366E-02	6.00869E+05	3.01255E+04
2.86699E+04	4.72212E-02	4.92995E+05	2.32798E+04
3.04075E+04	4.79649E-02	4.00152E+05	1.91933E+04
3.21450E+04	7.15253E-02	3.21680E+05	2.30083E+04
3.38826E+04	4.22944E-02	2.56368E+05	1.08429E+04
3.56202E+04	4.54260E-02	2.02726E+05	9.20903E+03
3.73578E+04	5.22036E-02	1.59175E+05	8.30951E+03
3.90953E+04	6.53089E-02	1.24175E+05	8.10976E+03
4.08329E+04	9.89472E-02	9.63011E+04	9.52872E+03
4.25705E+04	1.96891E-01	7.42803E+04	1.46251E+04
4.43080E+04	3.33401E-01	5.70097E+04	1.90071E+04
4.60456E+04	4.91230E-01	4.35534E+04	2.13947E+04
4.77832E+04	5.86873E-01	3.31315E+04	1.94440E+04
4.95207E+04	7.35747E-01	2.51037E+04	1.84700E+04
5.12583E+04	1.08894E+00	1.89509E+04	2.06364E+04
5.29959E+04	1.82110E+00	1.42570E+04	2.59633E+04
5.47335E+04	3.16397E+00	1.06911E+04	3.38263E+04
5.64710E+04	5.78476E+00	7.99288E+03	4.62369E+04
5.82086E+04	1.00625E+01	5.95869E+03	5.99596E+04
5.99462E+04	1.62660E+01	4.43034E+03	7.20639E+04
6.16837E+04	1.88199E+01	3.28571E+03	6.18367E+04
6.34213E+04	2.03035E+01	2.43101E+03	4.93580E+04
6.51589E+04	2.19663E+01	1.79459E+03	3.94204E+04
6.68964E+04	1.86836E+01	1.32196E+03	2.46989E+04

J TOTAL = 3.48565E+09

PLANCK MEAN OPACITY = 1.20239E-01 MEAN-SQUARED PLANCK MEAN OPACITY = 3.53848E-01
ROSSELAND MEAN-FREE-PATH = 1.29782E+01 1/ROSSELAND MEAN-FREE-PATH = 7.70523E-02
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 1.94683E+02 I PRIME = 2.30790E+02

TEMPERATURE = 6.50000E+03 C/H MASS RATIO = 5.00000E-02 PRESSURE = 5.00000E+02

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	2.16187E-01	1.22568E+06	2.64976E+05
9.55663E+03	4.49012E-01	1.42535E+06	6.39998E+05
1.12942E+04	6.93215E-01	1.53436E+06	1.06364E+06
1.30318E+04	6.75878E-01	1.55994E+06	1.05433E+06
1.47693E+04	4.22716E-01	1.51710E+06	6.41304E+05
1.65069E+04	2.14729E-01	1.42379E+06	3.05729E+05
1.82445E+04	1.74388E-01	1.29758E+06	2.26283E+05
1.99821E+04	2.49341E-01	1.15384E+06	2.87699E+05
2.17196E+04	2.64369E-01	1.00476E+06	2.65628E+05
2.34572E+04	3.83607E-01	8.59328E+05	3.29644E+05
2.51948E+04	1.46592E-01	7.23521E+05	1.06062E+05
2.69323E+04	9.42246E-02	6.00869E+05	5.66167E+04
2.86699E+04	6.97735E-02	4.92995E+05	3.43980E+04
3.04075E+04	7.14022E-02	4.00152E+05	2.85718E+04
3.21450E+04	1.60941E-01	3.21680E+05	5.17716E+04
3.38826E+04	5.28549E-02	2.56368E+05	1.35503E+04
3.56202E+04	5.92920E-02	2.02726E+05	1.20200E+04
3.73578E+04	7.19464E-02	1.59175E+05	1.14521E+04
3.90953E+04	1.00022E-01	1.24175E+05	1.24202E+04
4.08329E+04	1.88989E-01	9.63011E+04	1.81999E+04
4.25705E+04	6.42901E-01	7.42803E+04	4.77549E+04
4.43080E+04	9.01297E-01	5.70097E+04	5.13826E+04
4.60456E+04	1.29179E+00	4.35534E+04	5.62618E+04
4.77832E+04	1.31429E+00	3.31315E+04	4.35443E+04
4.95207E+04	1.21534E+00	2.51037E+04	3.05096E+04
5.12583E+04	1.43153E+00	1.89509E+04	2.71288E+04
5.29959E+04	2.20555E+00	1.42570E+04	3.14445E+04
5.47335E+04	3.73345E+00	1.06911E+04	3.99146E+04
5.64710E+04	6.68778E+00	7.99288E+03	5.34546E+04
5.82086E+04	1.14609E+01	5.95869E+03	6.82921E+04
5.99462E+04	1.82913E+01	4.43034E+03	8.10367E+04
6.16837E+04	2.16008E+01	3.28571E+03	7.09740E+04
6.34213E+04	2.40306E+01	2.43101E+03	5.84186E+04
6.51589E+04	2.69247E+01	1.79459E+03	4.83188E+04
6.68964E+04	2.34904E+01	1.32196E+03	3.10533E+04

J TOTAL = 1.07100E+10

PLANCK MEAN OPACITY = 3.69445E-01 MEAN-SQUARED PLANCK MEAN OPACITY = 6.33593E-01
ROSSELAND MEAN-FREE-PATH = 5.82169E+00 1/ROSSELAND MEAN-FREE-PATH = 1.71771E-01
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 5.60367E+01 I PRIME = 8.26480E+01

TEMPERATURE = 6.50000E+03 C/H MASS RATIO = 5.00000E-03 PRESSURE = 1.00000E+03

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	1.99862E-01	1.22568E+06	2.44893E+05
9.55663E+03	2.51292E-01	1.42535E+06	3.58178E+05
1.12942E+04	2.79668E-01	1.53436E+06	4.29111E+05
1.30318E+04	2.70640E-01	1.55994E+06	4.22182E+05
1.47693E+04	2.35268E-01	1.51710E+06	3.56926E+05
1.65069E+04	2.02498E-01	1.42379E+06	2.88313E+05
1.82445E+04	1.82229E-01	1.29758E+06	2.36457E+05
1.99821E+04	1.70981E-01	1.15384E+06	1.97284E+05
2.17196E+04	1.59091E-01	1.00476E+06	1.59849E+05
2.34572E+04	2.21235E-01	8.59328E+05	1.90113E+05
2.51948E+04	1.39603E-01	7.23521E+05	1.01006E+05
2.69323E+04	1.23921E-01	6.00869E+05	7.44601E+04
2.86699E+04	1.16993E-01	4.92995E+05	5.76772E+04
3.04075E+04	1.15476E-01	4.00152E+05	4.62080E+04
3.21450E+04	1.46107E-01	3.21680E+05	4.69997E+04
3.38826E+04	1.07623E-01	2.56368E+05	2.75911E+04
3.56202E+04	1.15727E-01	2.02726E+05	2.34609E+04
3.73578E+04	1.33322E-01	1.59175E+05	2.12215E+04
3.90953E+04	1.69331E-01	1.24175E+05	2.10268E+04
4.08329E+04	2.71508E-01	9.63011E+04	2.61465E+04
4.25705E+04	5.52994E-01	7.42803E+04	4.10765E+04
4.43080E+04	1.03897E+00	5.70097E+04	5.92315E+04
4.60456E+04	1.52429E+00	4.35534E+04	6.63879E+04
4.77832E+04	1.73306E+00	3.31315E+04	5.74188E+04
4.95207E+04	2.01839E+00	2.51037E+04	5.06692E+04
5.12583E+04	2.87233E+00	1.89509E+04	5.44334E+04
5.29959E+04	4.76847E+00	1.42570E+04	6.79839E+04
5.47335E+04	8.28690E+00	1.06911E+04	8.85959E+04
5.64710E+04	1.51681E+01	7.99288E+03	1.21237E+05
5.82086E+04	2.64074E+01	5.95869E+03	1.57354E+05
5.99462E+04	4.27257E+01	4.43034E+03	1.89290E+05
6.16837E+04	4.94412E+01	3.28571E+03	1.62449E+05
6.34213E+04	5.34361E+01	2.43101E+03	1.29904E+05
6.51589E+04	5.79837E+01	1.79459E+03	1.04057E+05
6.68964E+04	4.94398E+01	1.32196E+03	6.53573E+04

J TOTAL = 8.24399E+09

PLANCK MEAN OPACITY = 2.84379E-01 MEAN-SQUARED PLANCK MEAN OPACITY = 2.43607E+00
ROSSELAND MEAN-FREE-PATH = 5.56305E+00 1/ROSSELAND MEAN-FREE-PATH = 1.79757E-01
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 3.48254E+01 L PRIME = 4.01359E+01

TEMPERATURE = 6.50000E+03 C/H MASS RATIO = 1.00000E-02 PRESSURE = 1.00000E+03

OMEGA	TOTAL MU	B(K,T)	J
7.81906E+03	2.26283E-01	1.22568E+06	2.77350E+05
9.55663E+03	3.19188E-01	1.42535E+06	4.54954E+05
1.12942E+04	3.92095E-01	1.53436E+06	6.01615E+05
1.30318E+04	3.80463E-01	1.55994E+06	5.93500E+05
1.47693E+04	2.99092E-01	1.51710E+06	4.53754E+05
1.65069E+04	2.27667E-01	1.42379E+06	3.24149E+05
1.82445E+04	1.97109E-01	1.29758E+06	2.55766E+05
1.99821E+04	1.94038E-01	1.15384E+06	2.23888E+05
2.17196E+04	1.83266E-01	1.00476E+06	1.84139E+05
2.34572E+04	2.96643E-01	8.59328E+05	2.54914E+05
2.51948E+04	1.53844E-01	7.23521E+05	1.11310E+05
2.69323E+04	1.30855E-01	6.00869E+05	7.86269E+04
2.86699E+04	1.22693E-01	4.92995E+05	6.04870E+04
3.04075E+04	1.23964E-01	4.00152E+05	4.96043E+04
3.21450E+04	1.81110E-01	3.21680E+05	5.82595E+04
3.38826E+04	1.10069E-01	2.56368E+05	2.82181E+04
3.56202E+04	1.18538E-01	2.02726E+05	2.40307E+04
3.73578E+04	1.37628E-01	1.59175E+05	2.19069E+04
3.90953E+04	1.82198E-01	1.24175E+05	2.26245E+04
4.08329E+04	3.32138E-01	9.63011E+04	3.19853E+04
4.25705E+04	8.03055E-01	7.42803E+04	5.96511E+04
4.43080E+04	1.57529E+00	5.70097E+04	8.98067E+04
4.60456E+04	2.28539E+00	4.35534E+04	9.95365E+04
4.77832E+04	2.38192E+00	3.31315E+04	7.89164E+04
4.95207E+04	2.36274E+00	2.51037E+04	5.93135E+04
5.12583E+04	3.01250E+00	1.89509E+04	5.70898E+04
5.29959E+04	4.85626E+00	1.42570E+04	6.92355E+04
5.47335E+04	8.39977E+00	1.06911E+04	8.98027E+04
5.64710E+04	1.53455E+01	7.99288E+03	1.22655E+05
5.82086E+04	2.66831E+01	5.95869E+03	1.58996E+05
5.99462E+04	4.31411E+01	4.43034E+03	1.91130E+05
6.16837E+04	5.01184E+01	3.28571E+03	1.64675E+05
6.34213E+04	5.46555E+01	2.43101E+03	1.32868E+05
6.51589E+04	6.00225E+01	1.79459E+03	1.07716E+05
6.68964E+04	5.16462E+01	1.32196E+03	6.82741E+04

J TOTAL = 9.83594E+09

PLANCK MEAN OPACITY = 3.39294E-01 MEAN-SQUARED PLANCK MEAN OPACITY = 2.57986E+00
ROSSELAND MEAN-FREE-PATH = 4.86946E+00 1/ROSSELAND MEAN-FREE-PATH = 2.05362E-01
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 2.80573E+01 I PRIME = 3.36873E+01

TEMPERATURE = 6.50000E+03 C/H MASS RATIO = 5.00000E-02 PRESSURE = 1.00000E+03

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	5.90419E-01	1.22568E+06	7.23665E+05
9.55663E+03	1.26936E+00	1.42535E+06	1.80929E+06
1.12942E+04	1.97365E+00	1.53436E+06	3.02829E+06
1.30318E+04	1.92496E+00	1.55994E+06	3.00283E+06
1.47693E+04	1.19106E+00	1.51710E+06	1.80696E+06
1.65069E+04	5.69228E-01	1.42379E+06	8.10459E+05
1.82445E+04	3.92978E-01	1.29758E+06	5.09921E+05
1.99821E+04	5.03413E-01	1.15384E+06	5.80856E+05
2.17196E+04	5.33755E-01	1.00476E+06	5.36298E+05
2.34572E+04	8.45525E-01	8.59328E+05	7.26584E+05
2.51948E+04	3.52476E-01	7.23521E+05	2.55024E+05
2.69323E+04	2.32960E-01	6.00869E+05	1.39978E+05
2.86699E+04	1.72694E-01	4.92995E+05	8.51374E+04
3.04075E+04	1.74106E-01	4.00152E+05	6.96691E+04
3.21450E+04	3.67573E-01	3.21680E+05	1.18241E+05
3.38826E+04	1.33335E-01	2.56368E+05	3.41830E+04
3.56202E+04	1.50034E-01	2.02726E+05	3.04159E+04
3.73578E+04	1.86586E-01	1.59175E+05	2.96998E+04
3.90953E+04	2.90617E-01	1.24175E+05	3.60874E+04
4.08329E+04	7.08673E-01	9.63011E+04	6.82460E+04
4.25705E+04	2.38833E+00	7.42803E+04	1.77406E+05
4.43080E+04	4.45842E+00	5.70097E+04	2.54173E+05
4.60456E+04	6.37036E+00	4.35534E+04	2.77451E+05
4.77832E+04	5.96436E+00	3.31315E+04	1.97608E+05
4.95207E+04	4.47529E+00	2.51037E+04	1.12346E+05
5.12583E+04	4.20646E+00	1.89509E+04	7.97164E+04
5.29959E+04	5.99239E+00	1.42570E+04	8.54332E+04
5.47335E+04	1.00419E+01	1.06911E+04	1.07359E+05
5.64710E+04	1.79630E+01	7.99288E+03	1.43576E+05
5.82086E+04	3.07500E+01	5.95869E+03	1.83230E+05
5.99462E+04	4.90678E+01	4.43034E+03	2.17387E+05
6.16837E+04	5.85221E+01	3.28571E+03	1.92287E+05
6.34213E+04	6.69344E+01	2.43101E+03	1.62718E+05
6.51589E+04	7.82633E+01	1.79459E+03	1.40451E+05
6.68964E+04	6.98365E+01	1.32196E+03	9.23210E+04

J TOTAL = 2.92351E+10

PLANCK MEAN OPACITY = 1.00848E+00 MEAN-SQUARED PLANCK MEAN OPACITY = 5.04376E+00
ROSSELAND MEAN-FREE-PATH = 2.36715E+00 1/ROSSELAND MEAN-FREE-PATH = 4.22449E-01
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 9.17337E+00 I PRIME = 1.33088E+01

TEMPERATURE = 8.00000E+03 C/H MASS RATIO = 5.00000E-03 PRESSURE = 1.00000E+02

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	3.81673E-02	1.84809E+06	7.05368E+04
9.55663E+03	4.72935E-02	2.27081E+06	1.07394E+05
1.12942E+04	5.02765E-02	2.59042E+06	1.30237E+05
1.30318E+04	4.93752E-02	2.79800E+06	1.38152E+05
1.47693E+04	4.68858E-02	2.89737E+06	1.35845E+05
1.65069E+04	4.36515E-02	2.90059E+06	1.26615E+05
1.82445E+04	4.02945E-02	2.82424E+06	1.13801E+05
1.99821E+04	3.68731E-02	2.68647E+06	9.90585E+04
2.17196E+04	3.41436E-02	2.50506E+06	8.55319E+04
2.34572E+04	3.19348E-02	2.29608E+06	7.33250E+04
2.51948E+04	2.92308E-02	2.07317E+06	6.06004E+04
2.69323E+04	2.70439E-02	1.84732E+06	4.99588E+04
2.86699E+04	2.64590E-02	1.62689E+06	4.30460E+04
3.04075E+04	2.46353E-02	1.41785E+06	3.49290E+04
3.21450E+04	2.33290E-02	1.22411E+06	2.85572E+04
3.38826E+04	2.19699E-02	1.04793E+06	2.30229E+04
3.56202E+04	2.12601E-02	8.90243E+05	1.89266E+04
3.73578E+04	2.10161E-02	7.51022E+05	1.57836E+04
3.90953E+04	2.13283E-02	6.29546E+05	1.34271E+04
4.08329E+04	2.26142E-02	5.24642E+05	1.18643E+04
4.25705E+04	2.43945E-02	4.34876E+05	1.06086E+04
4.43080E+04	2.83519E-02	3.58687E+05	1.01695E+04
4.60456E+04	3.58934E-02	2.94494E+05	1.05704E+04
4.77832E+04	4.70911E-02	2.40763E+05	1.13378E+04
4.95207E+04	6.38585E-02	1.96060E+05	1.25201E+04
5.12583E+04	9.65679E-02	1.59070E+05	1.53610E+04
5.29959E+04	1.44292E-01	1.28015E+05	1.85582E+04
5.47335E+04	2.20911E-01	1.03657E+05	2.28990E+04
5.64710E+04	3.56412E-01	8.32903E+04	2.96857E+04
5.82086E+04	5.51508E-01	6.67356E+04	3.68052E+04
5.99462E+04	7.97791E-01	5.33286E+04	4.25451E+04
6.16837E+04	8.21445E-01	4.25078E+04	3.49178E+04
6.34213E+04	7.92950E-01	3.38021E+04	2.68034E+04
6.51589E+04	7.63666E-01	2.68189E+04	2.04807E+04
6.68964E+04	5.87681E-01	2.12330E+04	1.24782E+04

J TOTAL = 2.94753E+09

PLANCK MEAN OPACITY = 4.25217E-02 MEAN-SQUARED PLANCK MEAN OPACITY = 5.09679E-03
ROSSELAND MEAN-FREE-PATH = 3.10996E+01 1/ROSSELAND MEAN-FREE-PATH = 3.21547E-02
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 1.08015E+03 I PRIME = 1.22009E+03

TEMPERATURE = 8.00000E+03 C/H MASS RATIO = 1.00000E-02 PRESSURE = 1.00000E+02

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	3.82732E-02	1.84809E+06	7.07324E+04
9.55663E+03	4.74127E-02	2.27081E+06	1.07665E+05
1.12942E+04	5.04079E-02	2.59042E+06	1.30578E+05
1.30318E+04	4.95056E-02	2.79800E+06	1.38517E+05
1.47693E+04	4.70079E-02	2.89737E+06	1.36199E+05
1.65069E+04	4.37720E-02	2.90059E+06	1.26965E+05
1.82445E+04	4.04278E-02	2.82424E+06	1.14164E+05
1.99821E+04	3.70220E-02	2.68647E+06	9.94586E+04
2.17196E+04	3.42937E-02	2.50506E+06	8.59081E+04
2.34572E+04	3.25030E-02	2.29608E+06	7.46296E+04
2.51948E+04	2.93679E-02	2.07317E+06	6.08847E+04
2.69323E+04	2.71390E-02	1.84732E+06	5.01346E+04
2.86699E+04	2.65473E-02	1.62689E+06	4.31895E+04
3.04075E+04	2.47546E-02	1.41785E+06	3.50982E+04
3.21450E+04	2.36184E-02	1.22411E+06	2.89114E+04
3.38826E+04	2.20314E-02	1.04793E+06	2.30873E+04
3.56202E+04	2.13177E-02	8.90243E+05	1.89779E+04
3.73578E+04	2.10706E-02	7.51022E+05	1.58245E+04
3.90953E+04	2.13798E-02	6.29546E+05	1.34595E+04
4.08329E+04	2.26627E-02	5.24642E+05	1.18898E+04
4.25705E+04	2.44968E-02	4.34876E+05	1.06531E+04
4.43080E+04	2.83959E-02	3.58687E+05	1.01852E+04
4.60456E+04	3.59303E-02	2.94494E+05	1.05813E+04
4.77832E+04	4.71170E-02	2.40763E+05	1.13440E+04
4.95207E+04	6.38658E-02	1.96060E+05	1.25215E+04
5.12583E+04	9.65440E-02	1.59070E+05	1.53572E+04
5.29959E+04	1.44228E-01	1.28615E+05	1.85499E+04
5.47335E+04	2.20784E-01	1.03657E+05	2.28858E+04
5.64710E+04	3.56175E-01	8.32903E+04	2.96659E+04
5.82086E+04	5.51112E-01	6.67356E+04	3.67788E+04
5.99462E+04	7.97194E-01	5.33286E+04	4.25133E+04
6.16837E+04	8.20840E-01	4.25078E+04	3.48921E+04
6.34213E+04	7.92380E-01	3.38021E+04	2.67841E+04
6.51589E+04	7.63127E-01	2.68189E+04	2.04662E+04
6.68964E+04	5.87289E-01	2.12330E+04	1.24699E+04

J TOTAL = 2.95721E+09

PLANCK MEAN OPACITY = 4.26613E-02 MEAN-SQUARED PLANCK MEAN OPACITY = 5.10202E-03
ROSSELAND MEAN-FREE-PATH = 3.09569E+01 1/ROSSELAND MEAN-FREE-PATH = 3.23029E-02
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 1.07012E+03 I PRIME = 1.20950E+03

TEMPERATURE = 8.00000E+03 C/H MASS RATIO = 5.00000E-02 PRESSURE = 1.00000E+02

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	3.92937E-02	1.84809E+06	7.26184E+04
9.55663E+03	4.85479E-02	2.27081E+06	1.10243E+05
1.12942E+04	5.17193E-02	2.59042E+06	1.33975E+05
1.30318E+04	5.07995E-02	2.79800E+06	1.42137E+05
1.47693E+04	4.81731E-02	2.89737E+06	1.39575E+05
1.65069E+04	4.49705E-02	2.90059E+06	1.30467E+05
1.82445E+04	4.20087E-02	2.82424E+06	1.18643E+05
1.99821E+04	3.92564E-02	2.68647E+06	1.05461E+05
2.17196E+04	3.67225E-02	2.50506E+06	9.19923E+04
2.34572E+04	3.74750E-02	2.29608E+06	8.60456E+04
2.51948E+04	3.05220E-02	2.07317E+06	6.32773E+04
2.69323E+04	2.79321E-02	1.84732E+06	5.15996E+04
2.86699E+04	2.73021E-02	1.62689E+06	4.44176E+04
3.04075E+04	2.57434E-02	1.41785E+06	3.65001E+04
3.21450E+04	2.59503E-02	1.22411E+06	3.17660E+04
3.38826E+04	2.25706E-02	1.04793E+06	2.36523E+04
3.56202E+04	2.18346E-02	8.90243E+05	1.94381E+04
3.73578E+04	2.15693E-02	7.51022E+05	1.61990E+04
3.90953E+04	2.18605E-02	6.29546E+05	1.37622E+04
4.08329E+04	2.31306E-02	5.24642E+05	1.21353E+04
4.25705E+04	2.67206E-02	4.34876E+05	1.16201E+04
4.43080E+04	2.88453E-02	3.58687E+05	1.03465E+04
4.60456E+04	3.63204E-02	2.94494E+05	1.06961E+04
4.77832E+04	4.74528E-02	2.40763E+05	1.14249E+04
4.95207E+04	6.40660E-02	1.96060E+05	1.25608E+04
5.12583E+04	9.65287E-02	1.59070E+05	1.53548E+04
5.29959E+04	1.43967E-01	1.28615E+05	1.85164E+04
5.47335E+04	2.20155E-01	1.03657E+05	2.28207E+04
5.64710E+04	3.54872E-01	8.32903E+04	2.95574E+04
5.82086E+04	5.48823E-01	6.67356E+04	3.66260E+04
5.99462E+04	7.93632E-01	5.33286E+04	4.23233E+04
6.16837E+04	8.17456E-01	4.25078E+04	3.47483E+04
6.34213E+04	7.89439E-01	3.38021E+04	2.66847E+04
6.51589E+04	7.60483E-01	2.68189E+04	2.03953E+04
6.68964E+04	5.85670E-01	2.12330E+04	1.24355E+04

J TOTAL = 3.05815E+09

PLANCK MEAN OPACITY = 4.41175E-02 MEAN-SQUARED PLANCK MEAN OPACITY = 5.18559E-03
ROSSELAND MEAN-FREE-PATH = 2.96542E+01 1/ROSSELAND MEAN-FREE-PATH = 3.37220E-02
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 9.83299E+02 I PRIME = 1.11730E+03

TEMPERATURE = 8.00000E+03 C/H MASS RATIO = 5.00000E-03 PRESSURE = 5.00000E+02

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	3.86795E-01	1.84809E+06	7.14833E+05
9.55663E+03	4.68061E-01	2.27081E+06	1.06287E+06
1.12942E+04	4.94393E-01	2.59042E+06	1.28069E+06
1.30318E+04	4.83767E-01	2.79800E+06	1.35358E+06
1.47693E+04	4.57008E-01	2.89737E+06	1.32412E+06
1.65069E+04	4.25395E-01	2.90059E+06	1.23390E+06
1.82445E+04	3.92722E-01	2.82424E+06	1.10914E+06
1.99821E+04	3.59736E-01	2.68647E+06	9.66420E+05
2.17196E+04	3.33529E-01	2.50506E+06	8.35511E+05
2.34572E+04	3.18079E-01	2.29608E+06	7.30336E+05
2.51948E+04	2.87375E-01	2.07317E+06	5.95779E+05
2.69323E+04	2.66919E-01	1.84732E+06	4.93086E+05
2.86699E+04	2.55649E-01	1.62689E+06	4.15912E+05
3.04075E+04	2.40679E-01	1.41785E+06	3.41246E+05
3.21450E+04	2.33375E-01	1.22411E+06	2.85676E+05
3.38826E+04	2.22931E-01	1.04793E+06	2.33616E+05
3.56202E+04	2.25204E-01	8.90243E+05	2.00487E+05
3.73578E+04	2.34792E-01	7.51022E+05	1.76334E+05
3.90953E+04	2.53467E-01	6.29546E+05	1.59569E+05
4.08329E+04	2.90124E-01	5.24642E+05	1.52211E+05
4.25705E+04	3.36144E-01	4.34876E+05	1.46181E+05
4.43080E+04	4.24392E-01	3.58687E+05	1.52224E+05
4.60456E+04	5.82746E-01	2.94494E+05	1.71615E+05
4.77832E+04	8.11771E-01	2.40763E+05	1.95444E+05
4.95207E+04	1.15095E+00	1.96060E+05	2.25654E+05
5.12583E+04	1.80747E+00	1.59070E+05	2.87513E+05
5.29959E+04	2.76232E+00	1.28615E+05	3.55276E+05
5.47335E+04	4.29161E+00	1.03657E+05	4.44855E+05
5.64710E+04	6.99000E+00	8.32903E+04	5.82199E+05
5.82086E+04	1.08728E+01	6.67356E+04	7.25606E+05
5.99462E+04	1.57739E+01	5.33286E+04	8.41203E+05
6.16837E+04	1.62491E+01	4.25078E+04	6.90716E+05
6.34213E+04	1.56881E+01	3.38021E+04	5.30289E+05
6.51589E+04	1.51112E+01	2.68189E+04	4.05266E+05
6.68964E+04	1.16157E+01	2.12330E+04	2.46636E+05

J TOTAL = 3.41710E+10

PLANCK MEAN OPACITY = 4.92959E-01 MEAN-SQUARED PLANCK MEAN OPACITY = 1.58093E+00
ROSSELAND MEAN-FREE-PATH = 2.99218E+00 1/ROSSELAND MEAN-FREE-PATH = 3.34204E-01
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 1.00304E+01 I PRIME = 1.05835E+01

TEMPERATURE = 8.00000E+03 C/H MASS RATIO = 1.00000E-02 PRESSURE = 5.00000E+02

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	3.88342E-01	1.84809E+06	7.17691E+05
9.55663E+03	4.70076E-01	2.27081E+06	1.06745E+06
1.12942E+04	4.96889E-01	2.59042E+06	1.28715E+06
1.30318E+04	4.86245E-01	2.79800E+06	1.36051E+06
1.47693E+04	4.59057E-01	2.89737E+06	1.33006E+06
1.65069E+04	4.27165E-01	2.90059E+06	1.23903E+06
1.82445E+04	3.94600E-01	2.82424E+06	1.11444E+06
1.99821E+04	3.62135E-01	2.68647E+06	9.72866E+05
2.17196E+04	3.36026E-01	2.50506E+06	8.41767E+05
2.34572E+04	3.29768E-01	2.29608E+06	7.57175E+05
2.51948E+04	2.89564E-01	2.07317E+06	6.00317E+05
2.69323E+04	2.68255E-01	1.84732E+06	4.95554E+05
2.86699E+04	2.56891E-01	1.62689E+06	4.17934E+05
3.04075E+04	2.42647E-01	1.41785E+06	3.44036E+05
3.21450E+04	2.39140E-01	1.22411E+06	2.92734E+05
3.38826E+04	2.23681E-01	1.04793E+06	2.34401E+05
3.56202E+04	2.25903E-01	8.90243E+05	2.01108E+05
3.73578E+04	2.35469E-01	7.51022E+05	1.76842E+05
3.90953E+04	2.54179E-01	6.29546E+05	1.60017E+05
4.08329E+04	2.91097E-01	5.24642E+05	1.52722E+05
4.25705E+04	3.39261E-01	4.34876E+05	1.47536E+05
4.43080E+04	4.27299E-01	3.58687E+05	1.53267E+05
4.60456E+04	5.86355E-01	2.94494E+05	1.72678E+05
4.77832E+04	8.14880E-01	2.40763E+05	1.96193E+05
4.95207E+04	1.15271E+00	1.96060E+05	2.26000E+05
5.12583E+04	1.80796E+00	1.59070E+05	2.87592E+05
5.29959E+04	2.76201E+00	1.28615E+05	3.55237E+05
5.47335E+04	4.29061E+00	1.03657E+05	4.44752E+05
5.64710E+04	6.98783E+00	8.32903E+04	5.82019E+05
5.82086E+04	1.08690E+01	6.67356E+04	7.25348E+05
5.99462E+04	1.57680E+01	5.33286E+04	8.40884E+05
6.16837E+04	1.62448E+01	4.25078E+04	6.90530E+05
6.34213E+04	1.56868E+01	3.38021E+04	5.30248E+05
6.51589E+04	1.51132E+01	2.68189E+04	4.05318E+05
6.68964E+04	1.16206E+01	2.12330E+04	2.46740E+05

J TOTAL = 3.43486E+10

PLANCK MEAN OPACITY = 4.95520E-01 MEAN-SQUARED PLANCK MEAN OPACITY = 1.58228E+00
ROSSELAND MEAN-FREE-PATH = 2.96748E+00 1/ROSSELAND MEAN-FREE-PATH = 3.36986E-01
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 9.86299E+00 I PRIME = 1.04145E+01

TEMPERATURE = 8.00000E+03 C/H MASS RATIO = 5.00000E-02 PRESSURE = 5.00000E+02

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	4.09059E-01	1.84809E+06	7.55978E+05
9.55663E+03	5.01206E-01	2.27081E+06	1.13814E+06
1.12942E+04	5.39990E-01	2.59042E+06	1.39880E+06
1.30318E+04	5.26924E-01	2.79800E+06	1.47993E+06
1.47693E+04	4.90411E-01	2.89737E+06	1.42090E+06
1.65069E+04	4.50849E-01	2.90059E+06	1.30773E+06
1.82445E+04	4.23049E-01	2.82424E+06	1.19479E+06
1.99821E+04	4.04963E-01	2.68647E+06	1.08792E+06
2.17196E+04	3.83991E-01	2.50506E+06	9.61922E+05
2.34572E+04	4.30957E-01	2.29608E+06	9.89512E+05
2.51948E+04	3.08381E-01	2.07317E+06	6.39328E+05
2.69323E+04	2.79530E-01	1.84732E+06	5.16382E+05
2.86699E+04	2.67541E-01	1.62689E+06	4.35260E+05
3.04075E+04	2.58515E-01	1.41785E+06	3.66534E+05
3.21450E+04	2.84191E-01	1.22411E+06	3.47881E+05
3.38826E+04	2.30521E-01	1.04793E+06	2.41569E+05
3.56202E+04	2.32714E-01	8.90243E+05	2.07172E+05
3.73578E+04	2.42493E-01	7.51022E+05	1.82118E+05
3.90953E+04	2.61984E-01	6.29546E+05	1.64931E+05
4.08329E+04	3.01629E-01	5.24642E+05	1.58247E+05
4.25705E+04	3.97935E-01	4.34876E+05	1.73053E+05
4.43080E+04	4.54580E-01	3.58687E+05	1.63052E+05
4.60456E+04	6.19988E-01	2.94494E+05	1.82583E+05
4.77832E+04	8.46874E-01	2.40763E+05	2.03896E+05
4.95207E+04	1.17664E+00	1.96060E+05	2.30692E+05
5.12583E+04	1.82562E+00	1.59070E+05	2.90400E+05
5.29959E+04	2.77991E+00	1.28615E+05	3.57539E+05
5.47335E+04	4.31345E+00	1.03657E+05	4.47119E+05
5.64710E+04	7.01671E+00	8.32903E+04	5.84424E+05
5.82086E+04	1.09046E+01	6.67356E+04	7.27724E+05
5.99462E+04	1.58098E+01	5.33286E+04	8.43117E+05
6.16837E+04	1.63241E+01	4.25078E+04	6.93902E+05
6.34213E+04	1.58044E+01	3.38021E+04	5.34390E+05
6.51589E+04	1.52692E+01	2.68189E+04	4.09503E+05
6.68964E+04	1.17907E+01	2.12330E+04	2.50352E+05

J TOTAL = 3.66398E+10

PLANCK MEAN OPACITY = 5.28573E-01 MEAN-SQUARED PLANCK MEAN OPACITY = 1.62521E+00
ROSSELAND MEAN-FREE-PATH = 2.74038E+00 1/ROSSELAND MEAN-FREE-PATH = 3.64913E-01
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 8.48912E+00 I PRIME = 9.08149E+00

TEMPERATURE = 8.00000E+03 C/H MASS RATIO = 5.00000E-03 PRESSURE = 1.00000E+03

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	1.03483E+00	1.84809E+06	1.91246E+06
9.55663E+03	1.22317E+00	2.27081E+06	2.77758E+06
1.12942E+04	1.28142E+00	2.59042E+06	3.31941E+06
1.30318E+04	1.24863E+00	2.79800E+06	3.49367E+06
1.47693E+04	1.17546E+00	2.89737E+06	3.40574E+06
1.65069E+04	1.09251E+00	2.90059E+06	3.16892E+06
1.82445E+04	1.00779E+00	2.82424E+06	2.84624E+06
1.99821E+04	9.23200E-01	2.68647E+06	2.48015E+06
2.17196E+04	8.56186E-01	2.50506E+06	2.14480E+06
2.34572E+04	8.26181E-01	2.29608E+06	1.89698E+06
2.51948E+04	7.39867E-01	2.07317E+06	1.53387E+06
2.69323E+04	6.86347E-01	1.84732E+06	1.27160E+06
2.86699E+04	6.56847E-01	1.62689E+06	1.06862E+06
3.04075E+04	6.22127E-01	1.41785E+06	8.82080E+05
3.21450E+04	6.11113E-01	1.22411E+06	7.48069E+05
3.38826E+04	5.86589E-01	1.04793E+06	6.14703E+05
3.56202E+04	6.03879E-01	8.90243E+05	5.37599E+05
3.73578E+04	6.43787E-01	7.51022E+05	4.83498E+05
3.90953E+04	7.12420E-01	6.29546E+05	4.48501E+05
4.08329E+04	8.40222E-01	5.24642E+05	4.40816E+05
4.25705E+04	1.00202E+00	4.34876E+05	4.35755E+05
4.43080E+04	1.30280E+00	3.58687E+05	4.67299E+05
4.60456E+04	1.82695E+00	2.94494E+05	5.38026E+05
4.77832E+04	2.56959E+00	2.40763E+05	6.18662E+05
4.95207E+04	3.66288E+00	1.96060E+05	7.18143E+05
5.12583E+04	5.78595E+00	1.59070E+05	9.20369E+05
5.29959E+04	8.87933E+00	1.28615E+05	1.14202E+06
5.47335E+04	1.38357E+01	1.03657E+05	1.43417E+06
5.64710E+04	2.25783E+01	8.32903E+04	1.88056E+06
5.82086E+04	3.51575E+01	6.67356E+04	2.34626E+06
5.99462E+04	5.10365E+01	5.33286E+04	2.72170E+06
6.16837E+04	5.25860E+01	4.25078E+04	2.23532E+06
6.34213E+04	5.07875E+01	3.38021E+04	1.71672E+06
6.51589E+04	4.89415E+01	2.68189E+04	1.31256E+06
6.68964E+04	3.76292E+01	2.12330E+04	7.98982E+05

J TOTAL = 9.51525E+10

PLANCK MEAN OPACITY = 1.37269E+00 MEAN-SQUARED PLANCK MEAN OPACITY = 1.60394E+01
ROSSELAND MEAN-FREE-PATH = 1.13546E+00 1/ROSSELAND MEAN-FREE-PATH = 8.80701E-01
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 1.44912E+00 I PRIME = 1.49377E+00

TEMPERATURE = 8.00000E+03 C/H MASS RATIO = 1.00000E-02 PRESSURE = 1.00000E+03

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	1.03998E+00	1.84809E+06	1.92198E+06
9.55663E+03	1.23111E+00	2.27081E+06	2.79560E+06
1.12942E+04	1.29218E+00	2.59042E+06	3.34729E+06
1.30318E+04	1.25936E+00	2.79800E+06	3.52368E+06
1.47693E+04	1.18356E+00	2.89737E+06	3.42921E+06
1.65069E+04	1.09848E+00	2.90059E+06	3.18625E+06
1.82445E+04	1.01366E+00	2.82424E+06	2.86281E+06
1.99821E+04	9.30880E-01	2.68647E+06	2.50078E+06
2.17196E+04	8.64303E-01	2.50506E+06	2.16513E+06
2.34572E+04	8.65782E-01	2.29608E+06	1.98791E+06
2.51948E+04	7.46768E-01	2.07317E+06	1.54818E+06
2.69323E+04	6.92375E-01	1.84732E+06	1.27904E+06
2.86699E+04	6.60598E-01	1.62689E+06	1.07472E+06
3.04075E+04	6.28398E-01	1.41785E+06	8.90972E+05
3.21450E+04	6.30475E-01	1.22411E+06	7.71770E+05
3.38826E+04	5.88708E-01	1.04793E+06	6.16923E+05
3.56202E+04	6.05861E-01	8.90243E+05	5.39364E+05
3.73578E+04	6.45812E-01	7.51022E+05	4.85019E+05
3.90953E+04	7.15126E-01	6.29546E+05	4.50204E+05
4.08329E+04	8.46109E-01	5.24642E+05	4.43905E+05
4.25705E+04	1.02178E+00	4.34876E+05	4.44347E+05
4.43080E+04	1.33095E+00	3.58687E+05	4.77394E+05
4.60456E+04	1.86377E+00	2.94494E+05	5.48868E+05
4.77832E+04	2.60166E+00	2.40763E+05	6.26384E+05
4.95207E+04	3.68145E+00	1.96060E+05	7.21784E+05
5.12583E+04	5.79311E+00	1.59070E+05	9.21507E+05
5.29959E+04	8.88121E+00	1.28615E+05	1.14226E+06
5.47335E+04	1.38354E+01	1.03657E+05	1.43414E+06
5.64710E+04	2.25755E+01	8.32903E+04	1.88032E+06
5.82086E+04	3.51509E+01	6.67356E+04	2.34582E+06
5.99462E+04	5.10261E+01	5.33286E+04	2.72115E+06
6.16837E+04	5.25909E+01	4.25078E+04	2.23553E+06
6.34213E+04	5.08210E+01	3.38021E+04	1.71786E+06
6.51589E+04	4.90068E+01	2.68189E+04	1.31431E+06
6.68964E+04	3.77112E+01	2.12330E+04	8.00723E+05

J TOTAL = 9.58324E+10

PLANCK MEAN OPACITY = 1.38250E+00 MEAN-SQUARED PLANCK MEAN OPACITY = 1.60687E+01
ROSSELAND MEAN-FREE-PATH = 1.12292E+00 1/ROSSELAND MEAN-FREE-PATH = 8.90532E-01
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 1.41753E+00 I PRIME = 1.46191E+00

TEMPERATURE = 8.00000E+03 C/H MASS RATIO = 5.00000E-02 PRESSURE = 1.00000E+03

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	1.12467E+00	1.84809E+06	2.07849E+06
9.55663E+03	1.38142E+00	2.27081E+06	3.13693E+06
1.12942E+04	1.51253E+00	2.59042E+06	3.91810E+06
1.30318E+04	1.47815E+00	2.79800E+06	4.13586E+06
1.47693E+04	1.33415E+00	2.89737E+06	3.86551E+06
1.65069E+04	1.19188E+00	2.90059E+06	3.45716E+06
1.82445E+04	1.10735E+00	2.82424E+06	3.12742E+06
1.99821E+04	1.06880E+00	2.68647E+06	2.87129E+06
2.17196E+04	1.02014E+00	2.50506E+06	2.55552E+06
2.34572E+04	1.19469E+00	2.29608E+06	2.74309E+06
2.51948E+04	8.06662E-01	2.07317E+06	1.67235E+06
2.69323E+04	7.26910E-01	1.84732E+06	1.34284E+06
2.86699E+04	6.92277E-01	1.62689E+06	1.12626E+06
3.04075E+04	6.76901E-01	1.41785E+06	9.59741E+05
3.21450E+04	7.74491E-01	1.22411E+06	9.48060E+05
3.38826E+04	6.08511E-01	1.04793E+06	6.37675E+05
3.56202E+04	6.26452E-01	8.90243E+05	5.57694E+05
3.73578E+04	6.68880E-01	7.51022E+05	5.02344E+05
3.90953E+04	7.46176E-01	6.29546E+05	4.69752E+05
4.08329E+04	9.04602E-01	5.24642E+05	4.74593E+05
4.25705E+04	1.28857E+00	4.34876E+05	5.60366E+05
4.43080E+04	1.56322E+00	3.58687E+05	5.60708E+05
4.60456E+04	2.16672E+00	2.94494E+05	6.38084E+05
4.77832E+04	2.88376E+00	2.40763E+05	6.94303E+05
4.95207E+04	3.88197E+00	1.96060E+05	7.61098E+05
5.12583E+04	5.93618E+00	1.59070E+05	9.44266E+05
5.29959E+04	9.02891E+00	1.28615E+05	1.16125E+06
5.47335E+04	1.40370E+01	1.03657E+05	1.45503E+06
5.64710E+04	2.28614E+01	8.32903E+04	1.90414E+06
5.82086E+04	3.55475E+01	6.67356E+04	2.37229E+06
5.99462E+04	5.15537E+01	5.33286E+04	2.74929E+06
6.16837E+04	5.33810E+01	4.25078E+04	2.26911E+06
6.34213E+04	5.19348E+01	3.38021E+04	1.75551E+06
6.51589E+04	5.04223E+01	2.68189E+04	1.35227E+06
6.68964E+04	3.91762E+01	2.12330E+04	8.31828E+05

J TOTAL = 1.05280E+11

PLANCK MEAN OPACITY = 1.51879E+00 MEAN-SQUARED PLANCK MEAN OPACITY = 1.68915E+01
ROSSELAND MEAN-FREE-PATH = 1.01024E+00 1/ROSSELAND MEAN-FREE-PATH = 9.89861E-01
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 1.16971E+00 I PRIME = 1.22963E+00

TEMPERATURE = 1.00000E+04 C/H MASS RATIO = 5.00000E-03 PRESSURE = 1.00000E+02

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	1.68778E-01	2.73687E+06	4.61924E+05
9.55663E+03	1.88647E-01	3.51758E+06	6.63580E+05
1.12942E+04	1.88002E-01	4.20701E+06	7.90926E+05
1.30318E+04	1.81299E-01	4.77425E+06	8.65569E+05
1.47693E+04	1.76669E-01	5.20408E+06	9.19398E+05
1.65069E+04	1.62148E-01	5.49347E+06	8.90753E+05
1.82445E+04	1.48584E-01	5.64844E+06	8.39266E+05
1.99821E+04	1.35267E-01	5.68123E+06	7.68485E+05
2.17196E+04	1.24704E-01	5.60789E+06	6.99329E+05
2.34572E+04	1.14940E-01	5.44634E+06	6.26004E+05
2.51948E+04	1.06272E-01	5.21487E+06	5.54193E+05
2.69323E+04	9.81056E-02	4.93104E+06	4.83763E+05
2.86699E+04	1.11755E-01	4.61095E+06	5.15299E+05
3.04075E+04	1.03848E-01	4.26879E+06	4.43305E+05
3.21450E+04	9.72742E-02	3.91660E+06	3.80984E+05
3.38826E+04	9.02638E-02	3.56430E+06	3.21727E+05
3.56202E+04	8.35849E-02	3.21973E+06	2.69121E+05
3.73578E+04	7.81522E-02	2.88886E+06	2.25771E+05
3.90953E+04	7.46169E-02	2.57595E+06	1.92210E+05
4.08329E+04	7.23510E-02	2.28388E+06	1.65241E+05
4.25705E+04	7.13736E-02	2.01430E+06	1.43768E+05
4.43080E+04	7.26505E-02	1.76792E+06	1.28440E+05
4.60456E+04	7.75829E-02	1.54469E+06	1.19842E+05
4.77832E+04	8.63513E-02	1.34401E+06	1.16057E+05
4.95207E+04	9.78371E-02	1.16484E+06	1.13964E+05
5.12583E+04	1.20763E-01	1.00588E+06	1.21473E+05
5.29959E+04	1.51674E-01	8.65656E+05	1.31298E+05
5.47335E+04	1.98176E-01	7.42604E+05	1.47166E+05
5.64710E+04	2.75683E-01	6.35134E+05	1.75096E+05
5.82086E+04	3.75447E-01	5.41686E+05	2.03375E+05
5.99462E+04	4.85288E-01	4.60760E+05	2.23602E+05
6.16837E+04	4.57371E-01	3.90942E+05	1.78806E+05
6.34213E+04	4.04088E-01	3.30917E+05	1.33720E+05
6.51589E+04	3.58985E-01	2.79480E+05	1.00329E+05
6.68964E+04	2.62420E-01	2.35536E+05	6.18093E+04

J TOTAL = 2.28935E+10

PLANCK MEAN OPACITY = 1.32930E-01 MEAN-SQUARED PLANCK MEAN OPACITY = 2.09951E-02
ROSSELAND MEAN-FREE-PATH = 9.13193E+00 1/ROSSELAND MEAN-FREE-PATH = 1.09506E-01
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 9.29156E+01 I PRIME = 1.01574E+02

TEMPERATURE = 1.00000E+04 C/H MASS RATIO = 1.00000E-02 PRESSURE = 1.00000E+02

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	1.68855E-01	2.73687E+06	4.62132E+05
9.55663E+03	1.88650E-01	3.51758E+06	6.63591E+05
1.12942E+04	1.87985E-01	4.20701E+06	7.90856E+05
1.30318E+04	1.81274E-01	4.77425E+06	8.65448E+05
1.47693E+04	1.76637E-01	5.20408E+06	9.19234E+05
1.65069E+04	1.62118E-01	5.49347E+06	8.90592E+05
1.82445E+04	1.48561E-01	5.64844E+06	8.39140E+05
1.99821E+04	1.35256E-01	5.68123E+06	7.68420E+05
2.17196E+04	1.24702E-01	5.60789E+06	6.99312E+05
2.34572E+04	1.15054E-01	5.44634E+06	6.26624E+05
2.51948E+04	1.06286E-01	5.21487E+06	5.54267E+05
2.69323E+04	9.81164E-02	4.93104E+06	4.83816E+05
2.86699E+04	1.11762E-01	4.61095E+06	5.15330E+05
3.04075E+04	1.03872E-01	4.26879E+06	4.43406E+05
3.21450E+04	9.73412E-02	3.91660E+06	3.81246E+05
3.38826E+04	9.02803E-02	3.56430E+06	3.21786E+05
3.56202E+04	8.36033E-02	3.21973E+06	2.69180E+05
3.73578E+04	7.81729E-02	2.88886E+06	2.25830E+05
3.90953E+04	7.46386E-02	2.57595E+06	1.92266E+05
4.08329E+04	7.23732E-02	2.28388E+06	1.65291E+05
4.25705E+04	7.14017E-02	2.01430E+06	1.43824E+05
4.43080E+04	7.26701E-02	1.76792E+06	1.28475E+05
4.60456E+04	7.75974E-02	1.54469E+06	1.19864E+05
4.77832E+04	8.63579E-02	1.34401E+06	1.16066E+05
4.95207E+04	9.78337E-02	1.16484E+06	1.13960E+05
5.12583E+04	1.20740E-01	1.00588E+06	1.21450E+05
5.29959E+04	1.51626E-01	8.65656E+05	1.31256E+05
5.47335E+04	1.98090E-01	7.42604E+05	1.47102E+05
5.64710E+04	2.75533E-01	6.35134E+05	1.75001E+05
5.82086E+04	3.75215E-01	5.41686E+05	2.03249E+05
5.99462E+04	4.84965E-01	4.60760E+05	2.23453E+05
6.16837E+04	4.57082E-01	3.90942E+05	1.78692E+05
6.34213E+04	4.03852E-01	3.30917E+05	1.33641E+05
6.51589E+04	3.58791E-01	2.79480E+05	1.00275E+05
6.68964E+04	2.62309E-01	2.35536E+05	6.17832E+04

J TOTAL = 2.28940E+10

PLANCK MEAN OPACITY = 1.32933E-01 MEAN-SQUARED PLANCK MEAN OPACITY = 2.09910E-02
ROSSELAND MEAN-FREE-PATH = 9.13032E+00 1/ROSSELAND MEAN-FREE-PATH = 1.09525E-01
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 9.28753E+01 I PRIME = 1.01530E+02

TEMPERATURE = 1.00000E+04 C/H MASS RATIO = 5.00000E-02 PRESSURE = 1.00000E+02

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	1.69478E-01	2.73687E+06	4.63838E+05
9.55663E+03	1.88847E-01	3.51758E+06	6.64285E+05
1.12942E+04	1.88137E-01	4.20701E+06	7.91494E+05
1.30318E+04	1.81378E-01	4.77425E+06	8.65946E+05
1.47693E+04	1.76637E-01	5.20408E+06	9.19234E+05
1.65069E+04	1.62075E-01	5.49347E+06	8.90351E+05
1.82445E+04	1.48562E-01	5.64844E+06	8.39141E+05
1.99821E+04	1.35362E-01	5.68123E+06	7.69023E+05
2.17196E+04	1.24900E-01	5.60789E+06	7.00422E+05
2.34572E+04	1.16094E-01	5.44634E+06	6.32289E+05
2.51948E+04	1.06478E-01	5.21487E+06	5.55267E+05
2.69323E+04	9.82726E-02	4.93104E+06	4.84587E+05
2.86699E+04	1.11883E-01	4.61095E+06	5.15887E+05
3.04075E+04	1.04120E-01	4.26879E+06	4.44464E+05
3.21450E+04	9.79303E-02	3.91660E+06	3.83553E+05
3.38826E+04	9.04693E-02	3.56430E+06	3.22460E+05
3.56202E+04	8.38094E-02	3.21973E+06	2.69844E+05
3.73578E+04	7.83985E-02	2.88886E+06	2.26482E+05
3.90953E+04	7.48775E-02	2.57595E+06	1.92881E+05
4.08329E+04	7.26237E-02	2.28388E+06	1.65864E+05
4.25705E+04	7.18616E-02	2.01430E+06	1.44751E+05
4.43080E+04	7.29292E-02	1.76792E+06	1.28933E+05
4.60456E+04	7.78368E-02	1.54469E+06	1.20234E+05
4.77832E+04	8.65705E-02	1.34401E+06	1.16351E+05
4.95207E+04	9.80146E-02	1.16484E+06	1.14171E+05
5.12583E+04	1.20839E-01	1.00588E+06	1.21549E+05
5.29959E+04	1.51638E-01	8.65656E+05	1.31266E+05
5.47335E+04	1.97971E-01	7.42604E+05	1.47014E+05
5.64710E+04	2.75144E-01	6.35134E+05	1.74754E+05
5.82086E+04	3.74462E-01	5.41686E+05	2.02841E+05
5.99462E+04	4.83798E-01	4.60760E+05	2.22915E+05
6.16837E+04	4.56386E-01	3.90942E+05	1.78420E+05
6.34213E+04	4.03697E-01	3.30917E+05	1.33590E+05
6.51589E+04	3.58974E-01	2.79480E+05	1.00326E+05
6.68964E+04	2.63011E-01	2.35536E+05	6.19484E+04

J TOTAL = 2.29296E+10

PLANCK MEAN OPACITY = 1.33140E-01 MEAN-SQUARED PLANCK MEAN OPACITY = 2.10294E-02
ROSSELAND MEAN-FREE-PATH = 9.10618E+00 1/ROSSELAND MEAN-FREE-PATH = 1.09815E-01
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 9.23310E+01 I PRIME = 1.00907E+02

TEMPERATURE = 1.00000E+04 C/H MASS RATIO = 5.00000E-03 PRESSURE = 5.00000E+02

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	1.70741E+00	2.73687E+06	4.67295E+06
9.55663E+03	1.91444E+00	3.51758E+06	6.73421E+06
1.12942E+04	1.94704E+00	4.20701E+06	8.19122E+06
1.30318E+04	1.88803E+00	4.77425E+06	9.01393E+06
1.47693E+04	1.80876E+00	5.20408E+06	9.41291E+06
1.65069E+04	1.67611E+00	5.49347E+06	9.20765E+06
1.82445E+04	1.54529E+00	5.64844E+06	8.72849E+06
1.99821E+04	1.41397E+00	5.68123E+06	8.03310E+06
2.17196E+04	1.30984E+00	5.60789E+06	7.34542E+06
2.34572E+04	1.21268E+00	5.44634E+06	6.60464E+06
2.51948E+04	1.12399E+00	5.21487E+06	5.86148E+06
2.69323E+04	1.04189E+00	4.93104E+06	5.13762E+06
2.86699E+04	1.06951E+00	4.61095E+06	4.93145E+06
3.04075E+04	9.95101E-01	4.26879E+06	4.24787E+06
3.21450E+04	9.36909E-01	3.91660E+06	3.66949E+06
3.38826E+04	8.84214E-01	3.56430E+06	3.15160E+06
3.56202E+04	8.46359E-01	3.21973E+06	2.72505E+06
3.73578E+04	8.21234E-01	2.88886E+06	2.37243E+06
3.90953E+04	8.21654E-01	2.57595E+06	2.11654E+06
4.08329E+04	8.35718E-01	2.28388E+06	1.90868E+06
4.25705E+04	8.73018E-01	2.01430E+06	1.75852E+06
4.43080E+04	9.54509E-01	1.76792E+06	1.68749E+06
4.60456E+04	1.11378E+00	1.54469E+06	1.72044E+06
4.77832E+04	1.35791E+00	1.34401E+06	1.82504E+06
4.95207E+04	1.66550E+00	1.16484E+06	1.94004E+06
5.12583E+04	2.24164E+00	1.00588E+06	2.25482E+06
5.29959E+04	2.99994E+00	8.65656E+05	2.59692E+06
5.47335E+04	4.11983E+00	7.42604E+05	3.05940E+06
5.64710E+04	5.95369E+00	6.35134E+05	3.78139E+06
5.82086E+04	8.30447E+00	5.41686E+05	4.49842E+06
5.99462E+04	1.08917E+01	4.60760E+05	5.01848E+06
6.16837E+04	1.02601E+01	3.90942E+05	4.01110E+06
6.34213E+04	9.03371E+00	3.30917E+05	2.98941E+06
6.51589E+04	7.99625E+00	2.79480E+05	2.23479E+06
6.68964E+04	5.75515E+00	2.35536E+05	1.35554E+06

J TOTAL = 2.68973E+11

PLANCK MEAN OPACITY = 1.56178E+00 MEAN-SQUARED PLANCK MEAN OPACITY = 4.12254E+00
ROSSELAND MEAN-FREE-PATH = 8.19927E-01 1/ROSSELAND MEAN-FREE-PATH = 1.21962E+00
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 7.65292E-01 I PRIME = 7.66235E-01

TEMPERATURE = 1.00000E+04 C/H MASS RATIO = 1.00000E-02 PRESSURE = 5.00000E+02

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	1.70776E+00	2.73687E+06	4.67391E+06
9.55663E+03	1.91520E+00	3.51758E+06	6.73688E+06
1.12942E+04	1.94832E+00	4.20701E+06	8.19661E+06
1.30318E+04	1.88942E+00	4.77425E+06	9.02059E+06
1.47693E+04	1.80987E+00	5.20408E+06	9.41873E+06
1.65069E+04	1.67692E+00	5.49347E+06	9.21209E+06
1.82445E+04	1.54595E+00	5.64844E+06	8.73218E+06
1.99821E+04	1.41465E+00	5.68123E+06	8.03696E+06
2.17196E+04	1.31056E+00	5.60789E+06	7.34947E+06
2.34572E+04	1.21600E+00	5.44634E+06	6.62274E+06
2.51948E+04	1.12485E+00	5.21487E+06	5.86596E+06
2.69323E+04	1.04257E+00	4.93104E+06	5.14094E+06
2.86699E+04	1.07013E+00	4.61095E+06	4.93433E+06
3.04075E+04	9.96007E-01	4.26879E+06	4.25174E+06
3.21450E+04	9.38750E-01	3.91660E+06	3.67671E+06
3.38826E+04	8.84787E-01	3.56430E+06	3.15365E+06
3.56202E+04	8.46926E-01	3.21973E+06	2.72687E+06
3.73578E+04	8.21805E-01	2.88886E+06	2.37408E+06
3.90953E+04	8.22223E-01	2.57595E+06	2.11801E+06
4.08329E+04	8.36293E-01	2.28388E+06	1.90999E+06
4.25705E+04	8.73758E-01	2.01430E+06	1.76001E+06
4.43080E+04	9.55093E-01	1.76792E+06	1.68853E+06
4.60456E+04	1.11431E+00	1.54469E+06	1.72127E+06
4.77832E+04	1.35836E+00	1.34401E+06	1.82564E+06
4.95207E+04	1.66586E+00	1.16484E+06	1.94046E+06
5.12583E+04	2.24179E+00	1.00588E+06	2.25497E+06
5.29959E+04	2.99990E+00	8.65656E+05	2.59688E+06
5.47335E+04	4.11951E+00	7.42604E+05	3.05916E+06
5.64710E+04	5.95272E+00	6.35134E+05	3.78078E+06
5.82086E+04	8.30262E+00	5.41686E+05	4.49742E+06
5.99462E+04	1.08889E+01	4.60760E+05	5.01716E+06
6.16837E+04	1.02589E+01	3.90942E+05	4.01063E+06
6.34213E+04	9.03429E+00	3.30917E+05	2.98960E+06
6.51589E+04	7.99791E+00	2.79480E+05	2.23525E+06
6.68964E+04	5.75830E+00	2.35536E+05	1.35629E+06

J TOTAL = 2.69126E+11

PLANCK MEAN OPACITY = 1.56267E+00 MEAN-SQUARED PLANCK MEAN OPACITY = 4.12452E+00
ROSSELAND MEAN-FREE-PATH = 8.19275E-01 1/ROSSELAND MEAN-FREE-PATH = 1.22059E+00
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 7.64028E-01 I PRIME = 7.65035E-01

TEMPERATURE = 1.00000E+04 C/H MASS RATIO = 5.00000E-02 PRESSURE = 5.00000E+02

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	1.71977E+00	2.73687E+06	4.70678E+06
9.55663E+03	1.93476E+00	3.51758E+06	6.80568E+06
1.12942E+04	1.97753E+00	4.20701E+06	8.31947E+06
1.30318E+04	1.91916E+00	4.77425E+06	9.16257E+06
1.47693E+04	1.83038E+00	5.20408E+06	9.52547E+06
1.65069E+04	1.68692E+00	5.49347E+06	9.26705E+06
1.82445E+04	1.55039E+00	5.64844E+06	8.75730E+06
1.99821E+04	1.41841E+00	5.68123E+06	8.05829E+06
2.17196E+04	1.31507E+00	5.60789E+06	7.37474E+06
2.34572E+04	1.23870E+00	5.44634E+06	6.74637E+06
2.51948E+04	1.12787E+00	5.21487E+06	5.88171E+06
2.69323E+04	1.04434E+00	4.93104E+06	5.14968E+06
2.86699E+04	1.07187E+00	4.61095E+06	4.94234E+06
3.04075E+04	1.00019E+00	4.26879E+06	4.26958E+06
3.21450E+04	9.50377E-01	3.91660E+06	3.72224E+06
3.38826E+04	8.87221E-01	3.56430E+06	3.16232E+06
3.56202E+04	8.49837E-01	3.21973E+06	2.73625E+06
3.73578E+04	8.25409E-01	2.88886E+06	2.38449E+06
3.90953E+04	8.26657E-01	2.57595E+06	2.12943E+06
4.08329E+04	8.41885E-01	2.28388E+06	1.92276E+06
4.25705E+04	8.85432E-01	2.01430E+06	1.78352E+06
4.43080E+04	9.64035E-01	1.76792E+06	1.70433E+06
4.60456E+04	1.12525E+00	1.54469E+06	1.73817E+06
4.77832E+04	1.37204E+00	1.34401E+06	1.84402E+06
4.95207E+04	1.68368E+00	1.16484E+06	1.96122E+06
5.12583E+04	2.26522E+00	1.00588E+06	2.27854E+06
5.29959E+04	3.03277E+00	8.65656E+05	2.62533E+06
5.47335E+04	4.16598E+00	7.42604E+05	3.09367E+06
5.64710E+04	6.01536E+00	6.35134E+05	3.82056E+06
5.82086E+04	8.38402E+00	5.41686E+05	4.54151E+06
5.99462E+04	1.09896E+01	4.60760E+05	5.06359E+06
6.16837E+04	1.03959E+01	3.90942E+05	4.06420E+06
6.34213E+04	9.20061E+00	3.30917E+05	3.04464E+06
6.51589E+04	8.17603E+00	2.79480E+05	2.28503E+06
6.68964E+04	5.93791E+00	2.35536E+05	1.39859E+06

J TOTAL = 2.71533E+11

PLANCK MEAN OPACITY = 1.57664E+00 MEAN-SQUARED PLANCK MEAN OPACITY = 4.21728E+00
ROSSELAND MEAN-FREE-PATH = 8.13767E-01 1/ROSSELAND MEAN-FREE-PATH = 1.22885E+00
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 7.54326E-01 I PRIME = 7.54875E-01

TEMPERATURE = 1.00000E+04 C/H MASS RATIO = 5.00000E-03 PRESSURE = 1.00000E+03

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	4.60839E+00	2.73687E+06	1.26125E+07
9.55663E+03	5.12927E+00	3.51758E+06	1.80426E+07
1.12942E+04	5.22513E+00	4.20701E+06	2.19822E+07
1.30318E+04	5.06460E+00	4.77425E+06	2.41797E+07
1.47693E+04	4.82610E+00	5.20408E+06	2.51154E+07
1.65069E+04	4.47990E+00	5.49347E+06	2.46102E+07
1.82445E+04	4.13474E+00	5.64844E+06	2.33548E+07
1.99821E+04	3.78763E+00	5.68123E+06	2.15184E+07
2.17196E+04	3.51321E+00	5.60789E+06	1.97017E+07
2.34572E+04	3.25937E+00	5.44634E+06	1.77516E+07
2.51948E+04	3.02348E+00	5.21487E+06	1.57671E+07
2.69323E+04	2.80849E+00	4.93104E+06	1.38488E+07
2.86699E+04	2.81064E+00	4.61095E+06	1.29597E+07
3.04075E+04	2.62109E+00	4.26879E+06	1.11889E+07
3.21450E+04	2.47980E+00	3.91660E+06	9.71238E+06
3.38826E+04	2.36154E+00	3.56430E+06	8.41725E+06
3.56202E+04	2.29890E+00	3.21973E+06	7.40186E+06
3.73578E+04	2.27329E+00	2.88886E+06	6.56720E+06
3.90953E+04	2.33096E+00	2.57595E+06	6.00444E+06
4.08329E+04	2.42997E+00	2.28388E+06	5.54975E+06
4.25705E+04	2.61005E+00	2.01430E+06	5.25741E+06
4.43080E+04	2.94727E+00	1.76792E+06	5.21052E+06
4.60456E+04	3.56655E+00	1.54469E+06	5.50922E+06
4.77832E+04	4.49494E+00	1.34401E+06	6.04122E+06
4.95207E+04	5.65749E+00	1.16484E+06	6.59004E+06
5.12583E+04	7.81055E+00	1.00588E+06	7.85646E+06
5.29959E+04	1.06320E+01	8.65656E+05	9.20362E+06
5.47335E+04	1.47843E+01	7.42604E+05	1.09789E+07
5.64710E+04	2.15606E+01	6.35134E+05	1.36939E+07
5.82086E+04	3.02398E+01	5.41686E+05	1.63805E+07
5.99462E+04	3.97917E+01	4.60760E+05	1.83344E+07
6.16837E+04	3.74809E+01	3.90942E+05	1.46529E+07
6.34213E+04	3.29764E+01	3.30917E+05	1.09125E+07
6.51589E+04	2.91659E+01	2.79480E+05	8.15128E+06
6.68964E+04	2.09180E+01	2.35536E+05	4.92695E+06

J TOTAL = 7.81883E+11

PLANCK MEAN OPACITY = 4.53997E+00 MEAN-SQUARED PLANCK MEAN OPACITY = 4.42410E+01
ROSSELAND MEAN-FREE-PATH = 2.94992E-01 1/ROSSELAND MEAN-FREE-PATH = 3.38992E+00
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 1.00088E-01 I PRIME = 9.65290E-02

TEMPERATURE = 1.00000E+04 C/H MASS RATIO = 1.00000E-02 PRESSURE = 1.00000E+03

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	4.61291E+00	2.73687E+06	1.26249E+07
9.55663E+03	5.13453E+00	3.51758E+06	1.80611E+07
1.12942E+04	5.23232E+00	4.20701E+06	2.20124E+07
1.30318E+04	5.07172E+00	4.77425E+06	2.42137E+07
1.47693E+04	4.83085E+00	5.20408E+06	2.51401E+07
1.65069E+04	4.48200E+00	5.49347E+06	2.46217E+07
1.82445E+04	4.13537E+00	5.64844E+06	2.33584E+07
1.99821E+04	3.78803E+00	5.68123E+06	2.15206E+07
2.17196E+04	3.51370E+00	5.60789E+06	1.97044E+07
2.34572E+04	3.26944E+00	5.44634E+06	1.78065E+07
2.51948E+04	3.02458E+00	5.21487E+06	1.57728E+07
2.69323E+04	2.80900E+00	4.93104E+06	1.38513E+07
2.86699E+04	2.81112E+00	4.61095E+06	1.29619E+07
3.04075E+04	2.62269E+00	4.26879E+06	1.11957E+07
3.21450E+04	2.48493E+00	3.91660E+06	9.73248E+06
3.38826E+04	2.36211E+00	3.56430E+06	8.41926E+06
3.56202E+04	2.29956E+00	3.21973E+06	7.40396E+06
3.73578E+04	2.27409E+00	2.88886E+06	6.56952E+06
3.90953E+04	2.33193E+00	2.57595E+06	6.00695E+06
4.08329E+04	2.43123E+00	2.28388E+06	5.55264E+06
4.25705E+04	2.61234E+00	2.01430E+06	5.26204E+06
4.43080E+04	2.94946E+00	1.76792E+06	5.21440E+06
4.60456E+04	3.56910E+00	1.54469E+06	5.51315E+06
4.77832E+04	4.49771E+00	1.34401E+06	6.04494E+06
4.95207E+04	5.66062E+00	1.16484E+06	6.59369E+06
5.12583E+04	7.81403E+00	1.00588E+06	7.85997E+06
5.29959E+04	1.06365E+01	8.65656E+05	9.20759E+06
5.47335E+04	1.47906E+01	7.42604E+05	1.09836E+07
5.64710E+04	2.15682E+01	6.35134E+05	1.36987E+07
5.82086E+04	3.02486E+01	5.41686E+05	1.63853E+07
5.99462E+04	3.98016E+01	4.60760E+05	1.83390E+07
6.16837E+04	3.75008E+01	3.90942E+05	1.46606E+07
6.34213E+04	3.30056E+01	3.30917E+05	1.09221E+07
6.51589E+04	2.91998E+01	2.79480E+05	8.16075E+06
6.68964E+04	2.09556E+01	2.35536E+05	4.93580E+06

J TOTAL = 7.82449E+11

PLANCK MEAN OPACITY = 4.54326E+00 MEAN-SQUARED PLANCK MEAN OPACITY = 4.42955E+01
ROSSELAND MEAN-FREE-PATH = 2.94791E-01 1/ROSSELAND MEAN-FREE-PATH = 3.39224E+00
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 9.99546E-02 I PRIME = 9.64069E-02

TOTAL OPACITIES AND VOLUME EMISSION 12

TEMPERATURE = 1.00000E+04 C/H MASS RATIO = 5.00000E-02 PRESSURE = 1.00000E+03

OMEGA	TOTAL MU	B(W,T)	J
7.81906E+03	4.67752E+00	2.73687E+06	1.28018E+07
9.55663E+03	5.26192E+00	3.51758E+06	1.85093E+07
1.12942E+04	5.42211E+00	4.20701E+06	2.28109E+07
1.30318E+04	5.26558E+00	4.77425E+06	2.51392E+07
1.47693E+04	4.96757E+00	5.20408E+06	2.58516E+07
1.65069E+04	4.55072E+00	5.49347E+06	2.49992E+07
1.82445E+04	4.16402E+00	5.64844E+06	2.35202E+07
1.99821E+04	3.80523E+00	5.68123E+06	2.16184E+07
2.17196E+04	3.53052E+00	5.60789E+06	1.97988E+07
2.34572E+04	3.34687E+00	5.44634E+06	1.82282E+07
2.51948E+04	3.03568E+00	5.21487E+06	1.58307E+07
2.69323E+04	2.81568E+00	4.93104E+06	1.38842E+07
2.86699E+04	2.81795E+00	4.61095E+06	1.29934E+07
3.04075E+04	2.63764E+00	4.26879E+06	1.12595E+07
3.21450E+04	2.52512E+00	3.91660E+06	9.88986E+06
3.38826E+04	2.37182E+00	3.56430E+06	8.45389E+06
3.56202E+04	2.31189E+00	3.21973E+06	7.44368E+06
3.73578E+04	2.29040E+00	2.88886E+06	6.61664E+06
3.90953E+04	2.35360E+00	2.57595E+06	6.06276E+06
4.08329E+04	2.46065E+00	2.28388E+06	5.61982E+06
4.25705E+04	2.66701E+00	2.01430E+06	5.37216E+06
4.43080E+04	3.00317E+00	1.76792E+06	5.30936E+06
4.60456E+04	3.63878E+00	1.54469E+06	5.62079E+06
4.77832E+04	4.58814E+00	1.34401E+06	6.16649E+06
4.95207E+04	5.78139E+00	1.16484E+06	6.73437E+06
5.12583E+04	7.97905E+00	1.00588E+06	8.02595E+06
5.29959E+04	1.08726E+01	8.65656E+05	9.41189E+06
5.47335E+04	1.51297E+01	7.42604E+05	1.12353E+07
5.64710E+04	2.20386E+01	6.35134E+05	1.39974E+07
5.82086E+04	3.08753E+01	5.41686E+05	1.67247E+07
5.99462E+04	4.05925E+01	4.60760E+05	1.87034E+07
6.16837E+04	3.85046E+01	3.90942E+05	1.50530E+07
6.34213E+04	3.41695E+01	3.30917E+05	1.13073E+07
6.51589E+04	3.04201E+01	2.79480E+05	8.50180E+06
6.68964E+04	2.21469E+01	2.35536E+05	5.21640E+06

J TOTAL = 7.97045E+11

PLANCK MEAN OPACITY = 4.62802E+00 MEAN-SQUARED PLANCK MEAN OPACITY = 4.64514E+01
ROSSELAND MEAN-FREE-PATH = 2.91470E-01 1/ROSSELAND MEAN-FREE-PATH = 3.43088E+00
MEAN-SQUARED ROSSELAND MEAN-FREE-PATH = 9.79499E-02 I PRIME = 9.44237E-02

APPENDIX E

DESCRIPTION OF THE PHOION SUB-ROUTINE OF THE OPSAB COMPUTER PROGRAM

Since this sub-routine is a recent addition to the OPSAB program and has not been previously described in any referencable document, it will be discussed here in some detail. The remainder of the OPSAB computer program is thoroughly described in Ref. 24.

The aim of the PHOION sub-routine is to compute the averaged linear spectral absorption coefficients in the chosen spectral averaging intervals for photoionization absorption by neutral C-, N-, O-, and H-atoms (only C- and H-atoms are of interest in the present work). The approach adopted makes use of published photoionization cross section data for these atoms, together with the computed mole fractions of the atoms (from the HUG computer program). The cross section data are read into the OPSAB program in tabular form. These data are interpolated in each of the spectral averaging intervals to find the values of the cross sections at the interval mid-points. These, together with the input atomic mole fractions, yield the value of the spectral absorption coefficients at the mid-points of the spectral averaging intervals. These calculations are performed only for temperatures greater than 3000° K, since the available cross section data do not extend to temperatures below 3000° K for C-, N-, and O- atoms. This is not a serious limitation, since atomic photoionization absorption by these species is not important at temperatures less than 3000° K for the spectral range to which we limit our calculations with the OPSAB program (wavenumbers less than about 72,000 cm^{-1} ; the maximum wave number considered in the present work is less than 68,000 cm^{-1}).

We have taken the spectral absorption cross sections for neutral C-, N-, and O-atoms from the work of Wilson and Nicolet[38], who give tabular "effective" cross sections, summed over all permissible initial and final electronic states for the temperature range $T = 3000 - 24,000°$ K, in steps of 1000° K, and the wave number ranges $\omega = 1610 - 161,000$ cm^{-1}. Their "effective" cross sections, $\sigma_i(\omega, T)$ (cm^2), where i refers to the species neutral C-, N-, or O-atoms, are given per atom, regardless of its electronic state. We compute the number density of species i, N_i (cm^{-3}), from its known mole fraction, $C_i(P, T)$, from

$$N_i(P, T) = C_i(P, T)\ (0.73397 \times 10^{22})\ (P/T), \qquad \text{(E-1)}$$

where P(atm) is the gas pressure, and T($^\circ$K) its temperature. Then the spectral absorption coefficients for photoionization absorption, μ_i (cm^{-1}), are found from

$$\mu_i(\bar{\omega}, P, T) = \sigma_i(\bar{\omega}, T)\ N_i(P, T)\ , \qquad \text{(E-2)}$$

where the $\bar{\omega}$ are the mid-points of the spectral averaging intervals chosen. We should note here that the values of $\sigma_i(\omega, T)$ used also include the free-free contributions, but not the induced emission contributions. These give little error in our calculations of photoionization absorption, since the free-free contributions included are negligible for the spectral range and conditions of interest here and the induced emission effects are small, except for the lowest spectral frequencies at the highest temperatures considered here, where photoionization absorption is small compared to absorption due to other mechanisms, notably photodetachment absorption by H^--ions. The induced emission correction could have been added in Eq. (E-2), but this has not been done. The present author is not aware of any extensive calculations of absorption cross sections for neutral carbon atoms which do not include the free-free contributions, and for this reason the results of Ref.38 have been used.

For H-atoms we have used the photoionization cross-sections of McDowell[39] for electronic levels with principal quantum number n = 2 to 8, inclusive. We do not consider the n = 1 level, since its photoionization edge falls beyond the spectral range of our interest; the levels with n > 8 are neglected following the work of Marlow[40], which indicates that for the temperatures and pressures usually considered in calculations with the OPSAB computer program, that the level with n = 8 is approximately the highest having an appreciable occupation. This choice is somewhat arbitrary, but becomes quite reasonable at high gas pressures (~ 10 atm. and greater) and/or low temperatures. McDowell's theoretical cross sections extend to levels with n = 15[39], but we have limited the complexity of the computer calculations, without great loss in accuracy, by truncating the calculations at n = 8.

Tabular cross section data, taken from the continuous curves of McDowell, are input to the OPSAB program for levels with n = 2 to 8, inclusive. Interpolations in these tables by the OPSAB program yield the values of the cross sections at the mid-points, $\bar{\omega}$, of the

spectral averaging intervals chosen. The averaged linear spectral absorption coefficient for photoionization of neutral H-atoms, μ_H $(\bar{\omega}, T)$ (cm^{-1}), is then found from

$$\mu_H(\bar{\omega}, T) = \sum_{n=2}^{8} \sigma_n(\bar{\omega}) \cdot N_n(P, T), \qquad \text{(E-3)}$$

where the $\sigma_n(\bar{\omega})$ are the interpolated cross sections, and $N_n(P, T)$ is the occupation of the level with principal quantum number n (cm^{-3}), found from

$$N_n(P, T) = N_H(P, T)\ n^2 \cdot \exp\left\{-\frac{157890}{T}\left[1 - \frac{1}{n^2}\right]\right\} \qquad \text{(E-4)}$$

for n = 2 to 8, inclusive, with T the gas temperature and $N_H(P, T)$ (cm^{-3}) the number density of H-atoms. $N_H(P, T)$ is found from the computed mole fraction of H-atoms as in Eq. (E-1). The induced emission contributions have also not been taken into account here.

The OPSAB program sums the $\mu_i(\bar{\omega}, T)$, in each spectral averaging interval to obtain the total (averaged) linear spectral absorption coefficient (cm^{-1}), due to photoionization of C-, H-, N-, and O-atoms (for only C- and H-atoms in the present work), and prints this out, as well as the contribution due to each of the separate species considered. The averaged spectral absorption coefficients so computed are not strictly the local Planck mean values, but are sufficiently close to them, especially for narrow (a few thousand wave numbers and less) spectral averaging intervals, as to give little error in comparison to the inaccuracies inherent in the theoretical cross sections used.

APPENDIX F

NEW TECHNOLOGY AND PATENTS

After a diligent review of the work performed under this contract, NAS3-11842, it has been determined by Heliodyne Corporation that no new innovation, discovery, improvement, or invention was made during the course of the work performed, and that no patentable items can result from this work.

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