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INTERIM ABSORPTION COEFFICIENTS AND OPACITIES FOR HYDROGEN PLASMA AT HIGH PRESSURE

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16. Abstract

The spectral absorption coefficient was calculated for hydrogen for photons with wave numbers from 500 to 400 000 cm^{-1} (infrared, visible, and ultraviolet). The plasma was assumed to be in local thermodynamic equilibrium at temperatures from 3000^{o} to $90\ 000^{o}$ R (1667 to 50 000 K) and pressures from 100 to 1000 atm (1.013×10^{7} to 1.013×10^{8} N/m^{2}). Fifteen absorption processes were included. The calculation included the hydrogen triatomic molecular ion H_3^+ in the composition as well as deviations of the real index of refraction from one near the plasma wave number. Both caused significant effects on the spectral absorption coefficient. The Planck and Rosseland mean opacities were derived and calculated.

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SUMMARY

The spectral absorption coefficient was calculated for hydrogen for photons with wave numbers from 500 to 400 000 cm^{-1} (infrared, visible, and ultraviolet), neglecting scattering. The plasma was assumed to be in local thermodynamic equilibrium at temperatures from 3000° to 90 000° R (1667 to 50 000 K) and pressures from 100 to 1000 atm (1.013×10^7 to 1.013×10^8 N/m^2). Fifteen absorption processes were included, and each was found to make a significant contribution to the spectral absorption coefficient at some combination of pressure, temperature, and photon wave number. The calculation was performed on a high-speed digital computer and included the hydrogen triatomic molecular ion H_3^+ in the composition as well as deviations of the real index of refraction from 1 near the plasma wave number. Both caused significant effects on the spectral absorption coefficient. The calculation excluded atomic lines because no reliable shapes were available for the far wings.

The Planck and Rosseland mean opacities were derived for a nonscattering plasma with real index of refraction varying with photon wave number and were calculated for hydrogen. The Planck mean opacity was larger than the Rosseland mean opacity for all conditions; in the most extreme case, the Planck mean opacity was 2.5×10^8 times the Rosseland mean opacity. For easily explained reasons, the Rosseland mean opacity differed significantly from earlier results.

More analytical work, especially on line shapes, is needed to obtain more reliable values for the spectral absorption coefficient and opacities for the conditions cited above.

INTRODUCTION

In high-temperature propulsion devices such as gaseous-core nuclear rockets, an important mechanism of heat transfer is radiant energy exchange between volumes of

plasma and between the plasma and the wall (refs. 1 and 2). To calculate such heat transfer, it is necessary to know the spectral absorption coefficient and opacities of the plasma. The usual propellant in such devices is hydrogen.

The problem of calculating the spectral absorption coefficient and opacities of hydrogen is an old one in astrophysics, but most of the calculations for temperatures up to 50 000 K are for the low pressures that occur in the outer layers of stars and have small quantities of helium and metals added to the hydrogen. For pure hydrogen, Menzel and Pekeris (ref. 3) did one of the earliest calculations of the Rosseland mean opacity. Later Tsao (ref. 4) calculated the Rosseland mean for very high density. Aroeste and Benton (ref. 5) calculated the hemispherical emissivity. Mastrup (ref. 6) computed the spectral absorption coefficient of the continua. Olfe (ref. 7) found the hemispherical emissivity. Stewart and Pyatt (ref. 8) found the spectral absorption coefficient. Krascella (ref. 9) determined the spectral absorption coefficient and Rosseland mean opacity. Lasher, et al. (ref. 10) calculated the hemispherical emissivity. Yakobi, et al. (refs. 11 and 12) computed the flat layer emissivity. Moskvin (ref. 13) found the hemispherical emissivity. The latter three works were published last year. The studies cited were all theoretical, but there have also been a number of experimental studies. However, these cover only isolated ranges of temperature, pressure, and photon wave number (the reciprocal of wavelength).

A review of the applicability to gaseous-core nuclear rockets of the eleven calculations mentioned above revealed at least one of six types of deficiencies for each calculation. The six types of deficiencies were: (1) temperature range insufficient, (2) pressure range insufficient, (3) composition incorrect, (4) important transitions omitted, (5) lack of Planck or Rosseland mean opacity or both, and (6) invalid treatment of the far wings of the Lyman α line of atomic hydrogen.

The purpose of this report is to provide better values for spectral absorption coefficient, Planck mean opacity, and Rosseland mean opacity than heretofore available for use in studies of gaseous-core nuclear-rocket heat transfer and to discover what remaining problems are likely to be most important. The results should be considered interim rather than final.

This report gives spectral absorption coefficient, Planck mean opacity, and Rosseland mean opacity for hydrogen for temperatures from 3000° to $90\ 000^{\circ}$ R (1667 to 50 000 K), pressures from 100 to 1000 atm (1.0132×10^{7} to 1.0132×10^{8} N/m^2), and photon wave numbers from 1000 to 400 000 cm^{-1}. No atomic lines, molecular bands, or scattering are included.

Differences between this report and Krascella's calculations (ref. 9) are of particular interest because until now reference 9 has been used almost exclusively for studies of gaseous-core nuclear rockets. In reference 9 the small photon wave number (red) wing of the Lyman α resonance line of atomic hydrogen was the principal contributor to the spectral absorption coefficient for a wide range of conditions. However, Krascella's

expression for the absorption of Lyman α is only believed to be valid for photon wave numbers from about 81 300 to 83 300 cm^{-1}, which includes the line center (private communication from R. G. Breene, Jr., Physical Studies, Inc., Reno, Nev.). Measurements on monatomic gases (ref. 14) indicate that the resonance line wing far to the red of the line center has an absorption coefficient much less than the theory in reference 9 predicts. There is no valid theory for far wings of resonance lines at present. Consequently, Lyman α was omitted from this report because it was believed this procedure caused less error than including it incorrectly. Other differences between this report and reference 9 are given under RESULTS AND DISCUSSION. To facilitate comparison with reference 9, tables in this report are for the same conditions and have format resembling that in reference 9.

The novel features of this report are the inclusion of the hydrogen triatomic molecular ion H_3^+ in the composition and allowance for a variable real index of refraction.

ANALYSIS

This section is divided into five subsections. First the composition of hydrogen is found. From that, the real index of refraction and spectral absorption coefficient is calculated. The opacities are then computed by taking averages of the spectral absorption coefficient. The last subsection describes the computer program to accomplish these calculations.

Composition

The plasma was assumed to be in local thermodynamic equilibrium. For temperatures above 2000 K, the species included were the hydrogen atom H, the proton H^+, the free electron e^-, the hydrogen molecule H_2, the negative hydrogen ion H^-, the hydrogen diatomic molecular ion H_2^+, and the hydrogen triatomic molecular ion H_3^+. The Debye-Hückel theory was used, and composition was found by minimizing the Gibbs free energy of a closed, neutral system at constant temperature and pressure. For temperatures below 2000 K, the species included were H, e^-, H_2, H^-, and H_3^+, and composition was found by using equilibrium constants. The details of both methods of calculation are given in references 15 and 16, together with results. For this report a dimensionless density ρ_i was defined for each species.

$$\rho_i \equiv \frac{N_i}{N_o} \qquad (i = 1, 2, \ldots, 7) \tag{1}$$

where N_i is the number density of species i and N_o is the Loschmidt number. (Symbols are defined in appendix A.)

Real Index of Refraction

In most calculations of opacity, the real index of refraction is assumed to be 1. However, for plasmas the real index of refraction may be significantly different from 1 for photon frequencies near the electron plasma frequency ω_p. From reference 17, page 5,

$$\omega_p = \left(\frac{N_3 e^2}{m\epsilon_o}\right)^{1/2} \tag{2}$$

where e is the charge of an electron, m is its mass, and ϵ_o is the electric permittivity of free space. The photon wave number corresponding to the electron plasma frequency is designated $\tilde{\nu}_p$ and is found from the relation $\tilde{\nu}_p = \omega_p/2\pi c$. In this report $\tilde{\nu}_p$ is called the plasma wave number.

The real index of refraction is found from the complex dielectric coefficient for transverse electromagnetic waves K_T. This dielectric coefficient is given by (ref. 17, eqs. 3.46 and 3.94)

$$K_T = 1 - \left(\frac{\tilde{\nu}_p}{\tilde{\nu}}\right)^2 - i\left(\frac{\tilde{\nu}_p}{\tilde{\nu}}\right)^2 \frac{\nu_{e,t}}{2\pi c\tilde{\nu}} \tag{3}$$

where i is the imaginary unit, $\nu_{e,t}$ is the total effective collision frequency for free electrons, and $\tilde{\nu}$ is the photon wave number.

The calculation of $\nu_{e,t}$ requires several approximations. In this report it is assumed that

$$\nu_{e,t} = \nu_{e,31} + \nu_{e,32} + \nu_{e,34} + \nu_{e,36} + \nu_{e,37} \tag{4}$$

where $\nu_{e,31}$, $\nu_{e,32}$, $\nu_{e,34}$, $\nu_{e,36}$, and $\nu_{e,37}$ are the effective collision frequencies of electrons with ground state H, H^+, ground electronic state H_2, H_2^+, and H_3^+, respectively.

The frequencies $\nu_{e,31}$ and $\nu_{e,34}$ are found from equation (3.91) of reference 17

$$\nu_{e,31} = nc\left(\frac{\tilde{\nu}}{\tilde{\nu}_p}\right)^2 \alpha_{\tilde{\nu},III} \tag{5}$$

$$\nu_{e,34} = nc\left(\frac{\tilde{\nu}}{\tilde{\nu}_p}\right)^2 \alpha_{\tilde{\nu},X} \tag{6}$$

where $\alpha_{\tilde{\nu},III}$ and $\alpha_{\tilde{\nu},X}$ are the spectral linear absorption coefficients for H^- inverse bremsstrahlung and H_2^- inverse bremsstrahlung, respectively. Obtaining values of $\alpha_{\tilde{\nu},III}$ and $\alpha_{\tilde{\nu},X}$ for use in equations (5) and (6) presented a problem because the values in the literature were all calculated for a dilute gas with real index of refraction n assumed to be 1. However, $\nu_{e,31}$ and $\nu_{e,34}$ must be independent of $\tilde{\nu}$ (ref. 17), so $\alpha_{\tilde{\nu},III}$ and $\alpha_{\tilde{\nu},X}$ need not be known for $\tilde{\nu}$ near $\tilde{\nu}_p$, where n differs substantially from 1. Instead, the value of $\tilde{\nu}$ in equations (5) and (6) may be enough greater than $\tilde{\nu}_p$ that the value of n is as near 1 as desired and hence the values of $\alpha_{\tilde{\nu},III}$ and $\alpha_{\tilde{\nu},X}$ given in the literature are essentially correct.

The approach used here was to evaluate equations (5) and (6) for a dilute gas and with $\tilde{\nu}$ enough greater than $\tilde{\nu}_p$ that $n \approx 1$ but with $\tilde{\nu}$ nevertheless small enough that $\alpha_{\tilde{\nu},III}$ and $\alpha_{\tilde{\nu},X}$ were inversely proportional to $\tilde{\nu}^2$. This gives an excellent approximation for dilute gases. To carry out this approach, relations for $\alpha_{\tilde{\nu},III}$ and $\alpha_{\tilde{\nu},X}$ for small $\tilde{\nu}$ were obtained from Ohmura and Ohmura (ref. 18) and Somerville (ref. 19), respectively. These relations involve temperature-dependent quantities tabulated near the top of table III of reference 18 and table I of reference 19. In this report these temperature-dependent quantities are called ψ_{III} and ψ_X, respectively. In terms of them equations (5) and (6) become

$$\nu_{e,31} = \frac{\pi^2 c N_o m^3 e^6 k \psi_{III} \rho_{1\ddagger} T}{16 \epsilon_o^3 h^6} \tag{7}$$

$$\nu_{e,34} = \frac{\pi^2 c N_o m^3 e^6 k \psi_X \rho_{4\ddagger} T}{16 \epsilon_o^3 h^6} \tag{8}$$

where n has been set equal to 1.

Equations (7) and (8) apply to a dilute gas, but many of the cases in this report are not dilute. In fact, for the latter cases it is impossible to find a value of $\tilde{\nu}$ enough greater than $\tilde{\nu}_p$ that $n \approx 1$ and nevertheless small enough that $\alpha_{\tilde{\nu},III}$ and $\alpha_{\tilde{\nu},X}$ from references 18 and 19 are given exactly in terms of ψ_{III} and ψ_X (are inversely proportional to $\tilde{\nu}^2$). However, for all cases a value of $\tilde{\nu}$ could be found such that n did not deviate greatly from 1, and the use of ψ_{III} and ψ_X introduced no great error. Hence equations (7) and (8) are fair approximations for all cases in this report. In applying equations (7) and (8), ψ_{III} and ψ_X were calculated from the relations in references 18

and 19 rather than use the tables.

The effective collision frequency of electrons with H^+ is found by equating equations (3.66) and (3.91) of reference 17 and using equations (1) and (2) of this report.

$$\nu_{e,32} = \frac{e^4 N_o \rho_2 \bar{G}}{6\epsilon_o^2 (6\pi m k^3 T^3)^{1/2}} \tag{9}$$

Here $\bar{G}$ is the Gaunt factor for bremsstrahlung averaged over the electron velocity distribution. In this report it is approximated by 1. Equation (9) agrees with equation (3.95) of reference 17 for the case $\rho_2 = \rho_3$.

It is assumed that the effective collision frequency of electrons with H_2^+ or H_3^+ is given to a first approximation by equation (9) with ρ_2 replaced by the appropriate density and $\bar{G} = 1$.

$$\nu_{e,i} = \frac{e^4 N_o \rho_i}{6\epsilon_o^2 (6\pi m k^3 T^3)^{1/2}} \qquad (i = 36, 37) \tag{10}$$

This completes the calculation of the five effective collision frequencies needed to find $\nu_{e,t}$.

The real index of refraction n is found from equations (3.46) and (3.47) of reference 17.

$$n = \Re e\,(K_T^{1/2}) \tag{11}$$

where $\Re e$ is an operator which takes the real part of a complex number.

Spectral Absorption Coefficient

In this subsection the contributions of various transitions to the spectral linear absorption coefficient are found and added.

Transitions considered. - Fifteen processes were included in the calculation of the spectral absorption coefficient. They are as follows:

$$H + hc\tilde{\nu} \rightarrow H^+ + e^- \tag{a}$$

where $hc\tilde{\nu}$ is the energy of a photon. In this photoionization (or bound-free) transition, H can have different principal quantum numbers.

$$H^+ + e^- + hc\tilde{\nu} \rightarrow H^+ + e^- \quad \text{(b)}$$

This is a free-free transition, also known as H inverse bremsstrahlung (bremsstrahlung is called by the particle that would result if the two particles were to recombine).

$$H_2^+ + e^- + hc\tilde{\nu} \rightarrow H_2^+ + e^- \quad \text{(c)}$$

$$H_3^+ + e^- + hc\tilde{\nu} \rightarrow H_3^+ + e^- \quad \text{(d)}$$

$$H + e^- + hc\tilde{\nu} \rightarrow H + e^- \quad \text{(e)}$$

$$H_2 + e^- + hc\tilde{\nu} \rightarrow H_2 + e^- \quad \text{(f)}$$

$$H + H^+ + hc\tilde{\nu} \rightarrow H + H^+ \quad \text{(g)}$$

These are also inverse bremsstrahlung. The particles are assumed to be in their ground electronic states.

$$H^- + hc\tilde{\nu} \rightarrow H + e^- \quad \text{(h)}$$

This is photodetachment, also known as a bound-free transition. The H atom is in its ground electronic state.

$$H_2 + hc\tilde{\nu} \rightarrow H + H^* \quad \text{(i)}$$

This is photodissociation. The molecule H_2 and the atom H were both assumed to be in their ground electronic states, but H^* is an atom in an electronically excited state.

$$H_2 + hc\tilde{\nu} \rightarrow H_2^+ + e^- \quad \text{(j)}$$

This is photoionization. The molecule H_2 was assumed to be in its ground electronic state.

$$H + H + hc\tilde{\nu} \rightarrow H_2^* \quad \text{(k)}$$

This is quasimolecular transition. The two atoms are in their ground electronic states, but H_2^* is a molecule in its $1s\sigma 2s\sigma\, {}^3\Sigma_g^+$ excited electronic state.

$$H_2 + H_2 + hc\tilde{\nu} \rightarrow H_2 + H_2 \quad \text{(l)}$$

This is a pressure-induced translational transition with all the molecules in their ground electronic states. The product molecules have more kinetic energy than the reactant molecules.

$$H_2 + H_2 + hc\tilde{\nu} \rightarrow H_2^* + H_2 \qquad (m)$$

This is a pressure-induced rotational transition with all the molecules in their ground electronic states. The molecule H_2^* has more rotational energy than initially.

$$H_2 + H_2 + hc\tilde{\nu} \rightarrow H_2^{**} + H_2 \qquad (n)$$

This is a pressure-induced vibrational transition with all the molecules again in their ground electronic states. The molecule H_2^{**} has one more vibrational quanta than initially. Rotational energy can also change.

$$H_2^+ + hc\tilde{\nu} \rightarrow H + H^+ \qquad (o)$$

This is photodissociation. The H atom is in its ground electronic state.

The absorption coefficients for these transitions are given in the following paragraphs.

H photoionization. - The relations used for process (a) were identical to those in reference 9. The spectral linear absorption coefficient for this process is designated $a_{\tilde{\nu},I}$ in this report. Neither $a_{\tilde{\nu},I}$ nor the following $a_{\tilde{\nu},\text{Roman}}$ include the reduction of the absorption by stimulated emission.

H, H_2, H_3 inverse bremsstrahlung. - The spectral linear absorption coefficient for processes (b), (c), and (d) collectively was found by dividing Kramer's formula (ref. 3) by the real index of refraction because of the reasons given by Bekefi (ref. 17, pp. 47-52, 89).

$$a_{\tilde{\nu},II} = \frac{1}{48\pi^3}\left(\frac{2\pi}{3kT}\right)^{1/2} \frac{e^6 N_o^2 \rho_3 (\rho_2 + \rho_6 + \rho_7)}{c^4 h m^{3/2} \tilde{\nu}^3 \epsilon_o^3 n} \qquad (12)$$

H^- inverse bremsstrahlung. - The absorption coefficient $a_{\tilde{\nu},III}$ for process (e) was found by two methods. For photon wave numbers greater than twice the plasma wave number, the relations in reference 9 were used because for these conditions n is essentially 1. For photon wave numbers less than twice the plasma wave number, equation (3.91) of reference 17 was used.

$$a_{\tilde{\nu},\,III} = \frac{1}{n}\frac{\tilde{\nu}_p^2}{\tilde{\nu}^2}\frac{\nu_{e,31}}{c(1 - e^{-hc\tilde{\nu}/kT})} \qquad (\tilde{\nu} < 2\tilde{\nu}_p) \tag{13}$$

This can also be derived from equation (5) by use of the general relation between $\alpha_{\tilde{\nu}}$ and $a_{\tilde{\nu}}$ for local thermodynamic equilibrium.

$$\alpha_{\tilde{\nu}} = a_{\tilde{\nu}}(1 - e^{-hc\tilde{\nu}/kT}) \tag{14}$$

where the factor in parentheses is called the stimulated emission factor and is always less than 1. The effective collision frequency $\nu_{e,31}$ in equation (13) was obtained from equation (7).

H^- photodetachment. - The absorption coefficient $a_{\tilde{\nu},\,IV}$ for process (h) was found from the relation and numerical fit in reference 9.

H_2 photodissociation and photoionization. - The transitions (i) and (j) were considered collectively because their photon wave numbers overlap, and the sum of the two absorption coefficients is measured experimentally. All experiments have been performed at room temperature (see fig. 1). To avoid complicated calculations, it was assumed that the cross sections for both transitions were independent of temperature. A

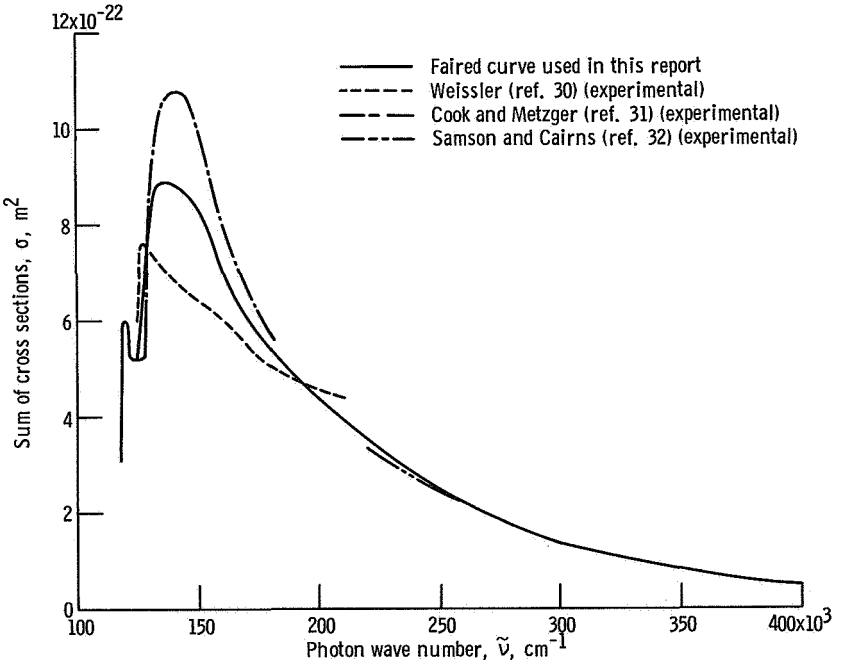


Figure 1. - Sum of cross sections for photodissociation and photoionization of H_2. All experimental curves are for room temperature. The faired curve merges with Cook and Metzger's curve at 124 000 cm^{-1} and below and with Samson and Cairn's curve above 270 000 cm^{-1}.

faired curve was drawn through the experimental sum of cross sections for the two transitions, as shown in figure 1. The absorption coefficient was found from the relation

$$a_{\tilde{\nu},V} = N_o \sigma \rho_{4\ddagger} \tag{15}$$

where the stimulated emission factor was omitted because it was essentially 1 for the high photon wave numbers involved.

H-H quasimolecular. - The absorption coefficient for process (k) was calculated by Doyle. His paper (ref. 20) contains a table of absorption coefficient $k_{\tilde{\nu}}$ for temperatures from 3000 to 8000 K. A more complete table of $k_{\tilde{\nu}}$ (2500 to 10 000 K) was very kindly provided (private communication from Robert O. Doyle, Smithsonian Institution Astrophysical Observatory, Cambridge, Mass.) and used in this report. The absorption coefficients $a_{\tilde{\nu},VI}$ and $k_{\tilde{\nu}}$ are related by

$$a_{\tilde{\nu},VI} = k_{\tilde{\nu}} N_o^2 \rho_{1\ddagger}^2 \tag{16}$$

H_2-H_2 pressure-induced translational. - The absorption coefficient for process (l) has been calculated for temperatures of 600 to 3000 K by using a model which fits the room temperature data (ref. 21). The given absorption coefficient $\kappa_{\tilde{\nu}}$ includes the stimulated emission factor. A numerical fit is provided for photon wave numbers less than 2000 cm^{-1}.

$$\kappa_{\tilde{\nu}} = a\tilde{\nu}^2 e^{-\tilde{\nu}/b} \qquad (\tilde{\nu} < \tilde{\nu}_c) \tag{17}$$

$$\kappa_{\tilde{\nu}} = Ce^{-\tilde{\nu}/d} \qquad (2000 \geq \tilde{\nu} \geq \tilde{\nu}_c) \tag{18}$$

where

$$a = 10^{-7.02391 - 1.3380 \log_{10} T} \tag{19}$$

$$b = 91.67 + 0.1033\ T \tag{20}$$

$$C = [15.57906 - 2.06158 \log_{10} T - 0.477352 (\log_{10} T)^2] \times 10^{-7} \tag{21}$$

$$d = 10^{2.31317 + 3.8856 \times 10^{-4} T} \tag{22}$$

$$\tilde{\nu}_c = 274.3 + 0.2762\ T \tag{23}$$

with T in K and $\kappa_{\tilde{\nu}}$ in cm^{-1} $Amagat^{-2}$. The absorption coefficients $\kappa_{\tilde{\nu}}$, and $a_{\tilde{\nu},\,VII}$ are related by

$$a_{\tilde{\nu},\,VII} = \frac{\kappa_{\tilde{\nu}} \rho_{4\ddagger}^2}{1 - e^{-hc\tilde{\nu}/kT}} \tag{24}$$

H_2-H_2 pressure-induced rotational. - The absorption coefficient for process (m) has also been computed for temperatures of 600 to 4000 K by using a model which fits the room temperature data (ref. 21). A numerical fit to the results is provided.

$$\kappa_{\tilde{\nu}} = a e^{-(\tilde{\nu}-\tilde{\nu}_o)^2/b} \qquad (\tilde{\nu} < 1.5\ \tilde{\nu}_o) \tag{25}$$

$$\kappa_{\tilde{\nu}} = C e^{-d\tilde{\nu}} \qquad (\tilde{\nu} \geq 1.5\ \tilde{\nu}_o) \tag{26}$$

where

$$a = 4.2432\times10^{-6} - 2.8854\times10^{-7} \ln T \tag{27}$$

$$b = 1.2171\times10^{5} + 258.28\ T \tag{28}$$

$$C = 2.5830\times10^{-4} - 4.3429\times10^{-8}\ T \tag{29}$$

$$d = 1.1332\times10^{-2} - 1.1943\times10^{-3} \ln T \tag{30}$$

$$\tilde{\nu}_o = -2973.3 + 600.73 \ln T \tag{31}$$

The absorption coefficients $\kappa_{\tilde{\nu}}$ and $a_{\tilde{\nu},\,VIII}$ are related by equation (24) with the subscript VII replaced by VIII.

H_2-H_2 pressure-induced vibrational. - The absorption coefficient for the process (n) has likewise been estimated for temperatures of 600 to 3000 K by using a model which fits the room temperature data (ref. 21). A numerical fit to the results is provided.

$$\kappa_{\tilde{\nu}} = \frac{\alpha' \delta \tilde{\nu} e^{(\tilde{\nu}-\tilde{\nu}_0)/0.6952T}}{(\tilde{\nu} - \tilde{\nu}_0)^2 + \delta^2} \qquad (\tilde{\nu} < \tilde{\nu}_0) \tag{32}$$

$$\kappa_{\tilde{\nu}} = \frac{\alpha' \delta \tilde{\nu}}{(\tilde{\nu} - \tilde{\nu}_0)^2 + \delta^2} \qquad (\tilde{\nu}_0 \leq \tilde{\nu} \leq \tilde{\nu}_0 + 1.5\ \delta) \tag{33}$$

$$\kappa_{\tilde{\nu}} = a\tilde{\nu}e^{-(\tilde{\nu}-\tilde{\nu}_0)/b} \qquad (\tilde{\nu} > \tilde{\nu}_0 + 1.5\,\delta) \tag{34}$$

where

$$\delta^2 = 1.2750\times10^5 + 437.50\,T \tag{35}$$

$$\alpha' = 10^{-7.0659+0.2825\,\log_{10}T} \tag{36}$$

$$a = \frac{1}{1.6288\times10^8 + 1.4904\times10^5\,T} \tag{37}$$

$$b = 10^{0.9376+0.5668\,\log_{10}T} \tag{38}$$

and $\tilde{\nu}_0 = 4161.1\ \text{cm}^{-1}$. The absorption coefficients $\kappa_{\tilde{\nu}}$ and $a_{\tilde{\nu},\,IX}$ are related by equation (24) with the subscript VII replaced by IX.

H_2^- inverse bremsstrahlung. - The absorption coefficient for process (f) has been calculated by Somerville (ref. 19) using exchange phase shifts calculated by Massey and Ridley (ref. 22) by Hulthen's variational method. Somerville gives a table of absorption coefficient for limited ranges of temperature and photon wave number. These ranges were too restricted for this report, so all absorption coefficients were calculated by numerical integration instead.

The first step in calculating the absorption coefficient was to fit Massey and Ridley's exchange phase shifts η_o calculated by Hulthén's variational method.

$$\eta_o(k_i) = 2.941 + (k_i - 0.143)\{-2.129 + (k_i - 0.143)[0.1655 + 0.2723(k_i - 0.143)]\}$$

$$(k_i \le 1.429) \tag{39}$$

where k_i is the wave number of the incident electron in atomic units and is given by $k_i = mv_i a_o/\hbar$. Equation (39) is based on calculated points for k_i between 0.143 and 1.429, so its use for k_i between 0 and 0.143 is an extrapolation. For k_i larger than 1.429, the extrapolation

$$\eta_o(k_i) = \text{arcctn}\left(0.6512\,k_i - \frac{0.5213}{k_i}\right) \tag{40}$$

was used, where η_o is in the first quadrant.

The final step is to calculate the spectral linear absorption coefficient from equations (39) and (40) and an appropriate relation. The general procedure used for H^- inverse bremsstrahlung was also used here. For photon wave numbers greater than twice the plasma wave number, Somerville's (ref. 19) relations were used.

$$a_{\tilde{\nu},X} = \frac{32N_o^2 a_o^2 \alpha h^3 \rho_{4\ddagger}\rho_3}{3(2\pi mkT)^{3/2}(\Delta k^2)^3} \int_0^\infty \frac{k_i^4 \sin^2\eta_o(k_f) + k_f^4 \sin^2\eta_o(k_i)}{k_f} e^{-\hbar^2 k_i^2/2kTma_o^2}\, dk_i$$

$$(\tilde{\nu} > 2\tilde{\nu}_p) \qquad (41)$$

where k_f is the final wave number of the electron and

$$\Delta k^2 \equiv k_f^2 - k_i^2 \qquad (42)$$

Consequently

$$\tilde{\nu} = \frac{h\,\Delta k^2}{8\pi^2 m a_o^2 c} \qquad (43)$$

For photon wave numbers less than twice the plasma wave number, equation (3.91) of reference 17 was used.

$$a_{\tilde{\nu},X} = \frac{1}{n}\frac{\tilde{\nu}_p^2}{\tilde{\nu}^2}\frac{\nu_{e,34}}{c(1 - e^{-hc\tilde{\nu}/kT})} \qquad (\tilde{\nu} < 2\tilde{\nu}_p) \qquad (44)$$

The effective collision frequency $\nu_{e,34}$ in equation (44) was obtained from equation (8).

H_2^+ photodissociation and inverse bremsstrahlung. - The absorption coefficient for processes (g) and (o) collectively has been calculated by Bates (ref. 23) for small photon wave numbers and by Solomon (ref. 24) for large photon wave numbers. Bate's table was used for photon wave numbers less than 25 000 cm^{-1}. Bate's absorption coefficient κ is related to the spectral linear absorption coefficient $a_{\tilde{\nu},XI}$ by

$$a_{\tilde{\nu},XI} = \frac{\kappa N_o^2 \rho_{1\ddagger}\rho_2}{1 - e^{-hc\tilde{\nu}/kT}} \qquad (\tilde{\nu} < 25\ 000\ cm^{-1}) \qquad (45)$$

A numerical fit to Solomon's (ref. 24) results has been given by Matsushima (ref. 25)

for temperatures from 5000 to 15 000 K and was used in this report for photon wave numbers from 25 000 to 118 260 cm^{-1}.

$$a_{\tilde{\nu},XI} = \frac{f10^{(2.92-4.2\lambda)\theta+1.49\lambda}\rho_1\rho_2}{1 - e^{-hc\tilde{\nu}/kT}} \qquad (\tilde{\nu} > 25\ 000\ cm^{-1}) \tag{46}$$

where λ is wavelength in microns, $\theta = 5040^{\circ}\ K/T$, and $f = 0.014545\ cm^{-1}$.

Spectral linear absorption coefficient. - The spectral linear absorption coefficient $\alpha_{\tilde{\nu}}$ including stimulated emission is the sum of the absorption coefficients for the various processes multiplied by the stimulated emission factor.

$$\alpha_{\tilde{\nu}} = (1 - e^{-hc\tilde{\nu}/kT}) \sum_{i=I}^{XI} a_{\tilde{\nu},i} \tag{47}$$

Unfortunately, for various reasons, $a_{\tilde{\nu},i}$ were not available for all transitions for all temperatures and photon wave numbers. The temperatures and photon wave numbers for which $a_{\tilde{\nu},i}$ were available are given in table I. For other temperatures and photon wave numbers they were neglected.

Opacities

Planck mean opacity. - The Planck mean opacity is used to calculate heat transfer from optically thin (semi-transparent) plasmas. A definition and derivation of the Planck mean opacity α_{Pl} for a nonscattering plasma with real index of refraction varying with photon wave number is given in appendix B. The relation between α_{Pl} and $\alpha_{\tilde{\nu}}$ (eq. (B7)) is the same as for a plasma with real index of refraction of 1.

Rosseland mean opacity. - The Rosseland mean opacity is used to calculate heat transfer inside optically thick (opaque) plasmas. A definition and derivation of the Rosseland mean opacity α_{Ro} for a nonscattering plasma with real index of refraction varying with photon wave number is given in appendix C. The relation between α_{Ro} and $\alpha_{\tilde{\nu}}$ (eq. (C11)) contains an n^2 in its integrand, which may be omitted if the plasma has a real index of refraction of 1, thereby giving the customary relation for $n = 1$.

Computer Program

The composition, absorption coefficient, and opacity calculations in this report were

performed with a program for a high-speed digital computer. The program was written in FORTRAN IV, IBM version 13. The Program for Components of a Hydrogen Plasma Including Minor Species (ref. 15) was included as a subprogram.

RESULTS AND DISCUSSION

This section is divided into six subsections. The results for composition, real index of refraction, spectral absorption coefficient, and opacities are given and discussed. Then a comparison with other investigators is made. Finally, the need for more work is outlined.

Composition

As pointed out in Analysis, the compositions were calculated by the methods in reference 15. However, the temperatures are, in general, different from those in reference 15, as well as most of the pressures. Consequently, the number densities of the seven species are given for reference in tables II to VII for pressures of 100, 250, 300, 500, 750, and 1000 atm (0.1013×10^8, 0.2533×10^8, 0.3040×10^8, 0.5066×10^8, 0.7599×10^8, and 0.1013×10^9 N/m^2). The number densities of H and H_2 are divided into contributions due to the ground electronic state and to excited electronic states. The total number density of all species as well as the mass density of the plasma (or simply density) are also given. The ionization potential of the ground electronic state of H is included in these tables too. It varies due to the Debye-Hückel effect.

Real Index of Refraction

The real index of refraction is a function of temperature, pressure, and photon wave number. In this report contributions to the real index of refraction due only to plasma effects were included (eqs. (3) to (11)), so the index differs appreciably from 1 only near the plasma wave number. The plasma wave number never exceeded 3000 cm^{-1} in this report, so the real index of refraction differed significantly from 1 only in the infrared. The real index of refraction for 1000 atm (1.013×10^8 N/m^2) is shown in figure 2. The real index of refraction effects the spectral absorption coefficient through equations (12), (13), and (44) and effects the Rosseland mean opacity not only through the spectral absorption coefficient but also through equation (C11).

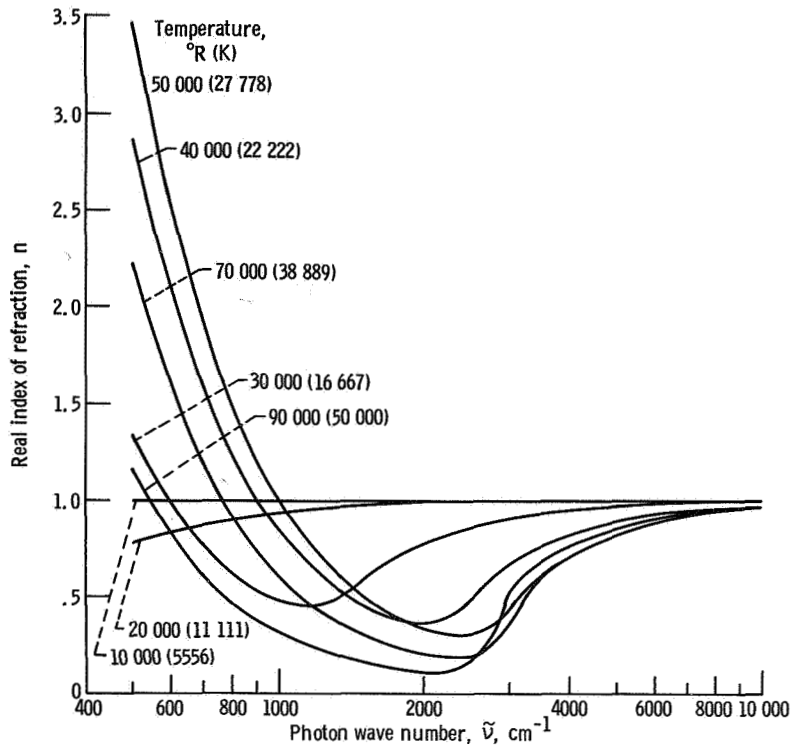
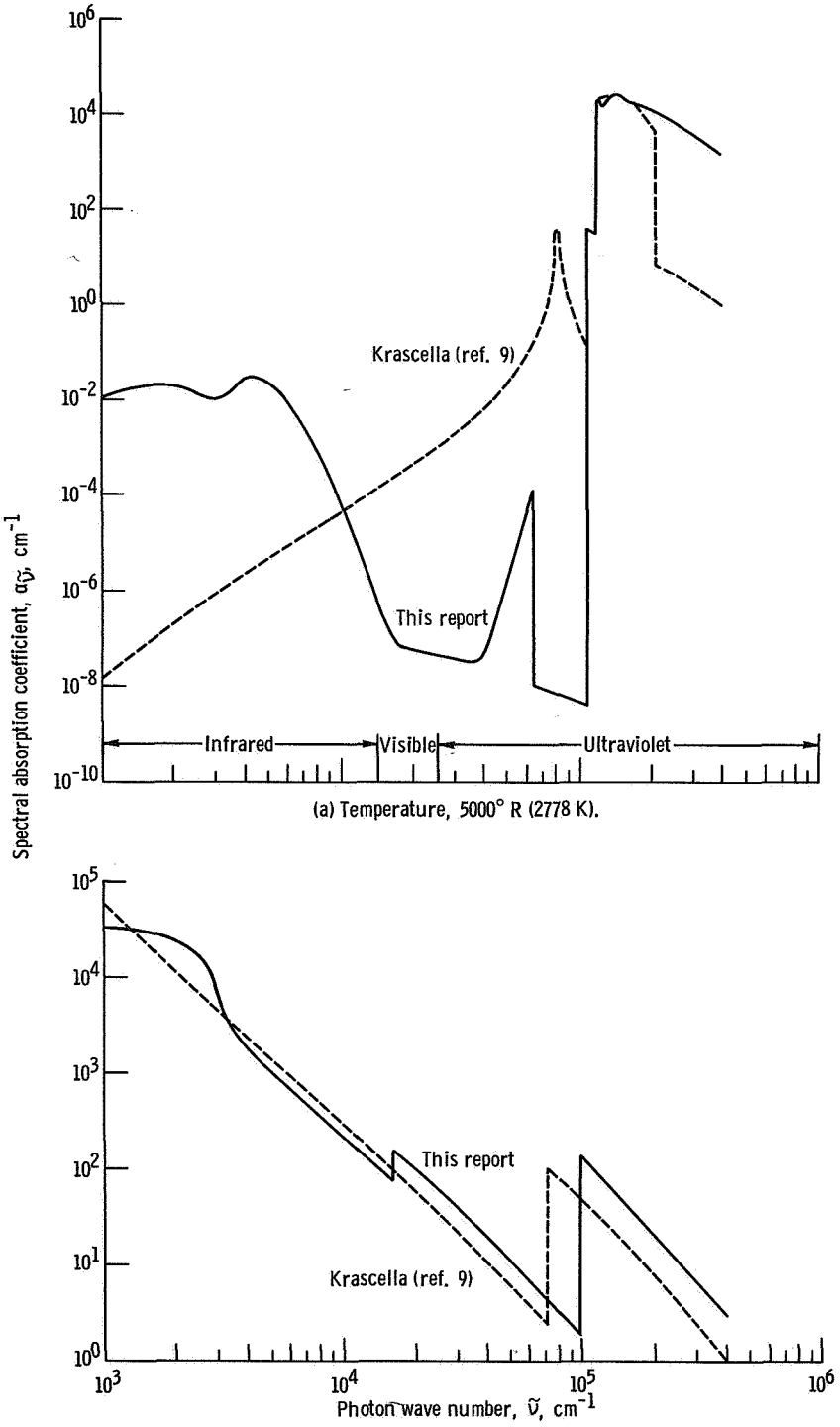


Figure 2. - Real index of refraction for hydrogen at pressure of 1000 atmospheres (1.013×10^8 N/m^2) in the infrared.

Spectral Absorption Coefficient

Spectral linear absorption coefficients $\alpha_{\tilde{\nu}}$ are given in the three columns labeled "absorption coefficient" in each part of tables II to VII. Corresponding photon wave numbers are printed before them.

The solid lines in figure 3 give the spectral absorption coefficient plotted against photon wave number for two different temperatures and a pressure of 1000 atm (1.013×10^8 N/m^2). Figure 3(a) is for 5000° R (2778 K). The first and second peaks are due to H_2-H_2 pressure-induced rotational and vibrational transitions, respectively. In the valley in the visible region, most of the absorption is due to H^- photodetachment. This valley would be much deeper if H_3^+ had not been included in the composition. The third peak is due to H-H quasimolecular absorption. It ceases at 64 935 cm^{-1} because no reliable calculations of quasimolecular absorption were available for larger photon wave numbers. In the valley around 10^5 cm^{-1}, most of the absorption is due to H^- photodetachment. From 109 678 to 118 257 cm^{-1} most of the absorption is due to H photoionization. To the violet of 118 257 cm^{-1}, most of the absorption is due to H_2 photodissociation or photoionization.



(a) Temperature, 5000° R (2778 K).

(b) Temperature, 70 000° R (38 889 K).

Figure 3. - Spectral absorption coefficient of hydrogen for pressure of 1000 atmospheres (1.013×10^8 N/m^2).

Figure 3(b) is for 70 000° R (38 889 K). To the red of 15 996 cm^{-1} most of the absorption is due to H inverse bremsstrahlung. The curvature at small photon wave numbers is due to variation in the real index of refraction. To the violet of 15 996 cm^{-1} most of the absorption is due to H photoionization.

The restricted ranges of photon wave numbers and temperatures for which calculations were available for various transitions (see table I) seriously effected the accuracy of some of the spectral absorption coefficients $\alpha_{\tilde{\nu}}$. One such instance has already been discussed with regard to figure 3(a). The lack of calculations for high temperatures for H_2-H_2 pressure-induced vibrational and rotational transitions was also serious, as shown in figure 4. Lack of calculations for high temperatures for H-H quasimolecular

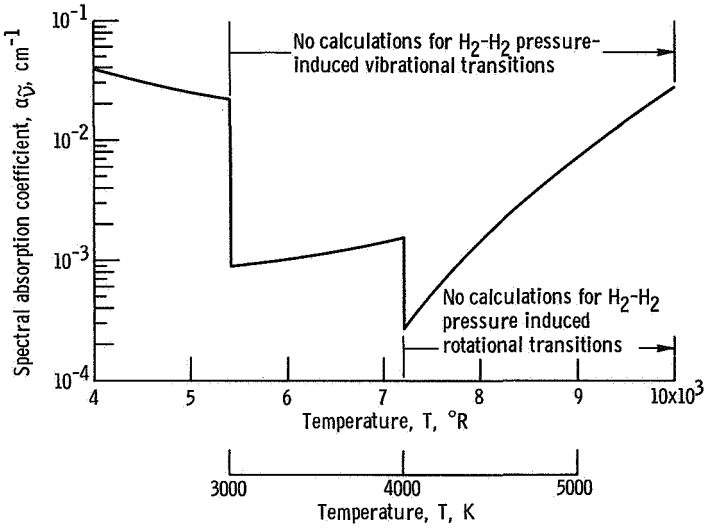


Figure 4. - Effect of lack of calculations for high temperatures for H_2-H_2 pressure-induced vibrational and rotational transitions. Pressure, 1000 atmospheres (1.013x10^8 N/m^2). Photon wave number, 4000 reciprocal centimeters.

absorption was likewise bad, as shown in figure 5. Less serious, but not negligible, were discontinuities in $\alpha_{\tilde{\nu}}$ due to lack of H_2-H_2 pressure-induced translational transition calculations at high temperatures and lack of H_2^+ photodissociation calculations at temperatures outside the range 5000 to 15 000 K for photon wave numbers around 10^5 cm^{-1}.

The relative importance of the transitions considered aids in understanding the spectrum, but space limitations precluded publishing such tables in this report for each pressure and temperature of tables II to VII. However, relative importance tables were calculated. The relative importance of the various categories of transitions varied greatly with photon wave number, temperature, and pressure, but each category was important for some combination of these three variables. This result is summarized in

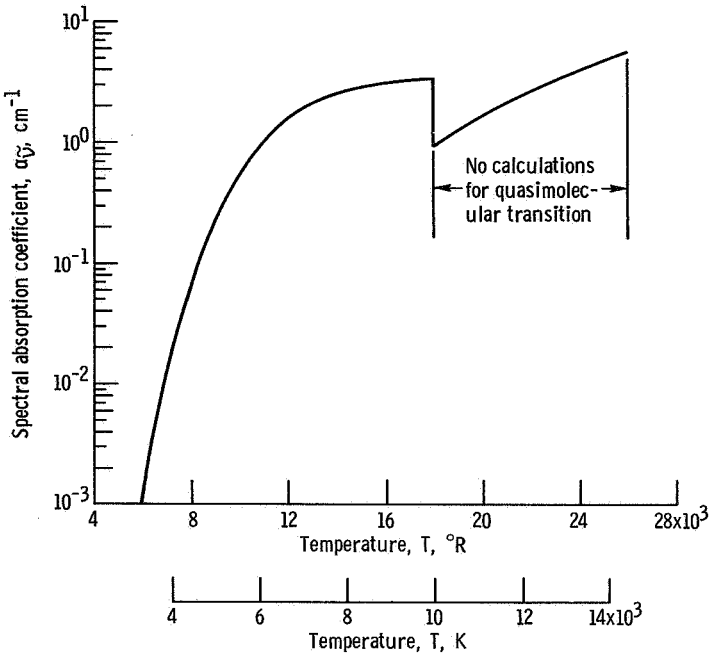


Figure 5. - Effect of lack of calculations for high temperatures for quasimolecular transition. Pressure, 1000 atmospheres ($1.013x10^{8}$ N/m^{2}). Photon wave number, 60 000 reciprocal centimeters.

table VIII, which includes all transitions considered in this report. Each of the categories of transitions in table VIII had a relative contribution to $\alpha_{\tilde{\nu}}$ of at least 36 percent for some combination of photon wave number, temperature, and pressure. However, table VIII is based on only 55 combinations of temperature and pressure and on 50 photon wave numbers between 500 and 400 000 cm^{-1}, so the true maximum relative contributions may be slightly higher than given. Also, no allowance could be made for the lack of calculations for certain transitions for certain photon wave numbers and temperatures (see table I).

Opacities

The Planck and Rosseland mean opacities were found from $\alpha_{\tilde{\nu}}$ and n calculated for 50 different photon wave numbers between 500 and 400 000 cm^{-1}. Numerical integration of equations (B7) and (C11) was by the trapezoidal rule. The lower limit of integration was 500 cm^{-1} and the upper limit was the smaller of 400 000 cm^{-1} and 40kT/hc. Results are given in tables II to VII and in figures 6 and 7.

Figure 6 gives the Planck mean opacity α_{Pl} for hydrogen. The discontinuities are due to lack of calculations for high temperatures for pressure-induced vibrational and

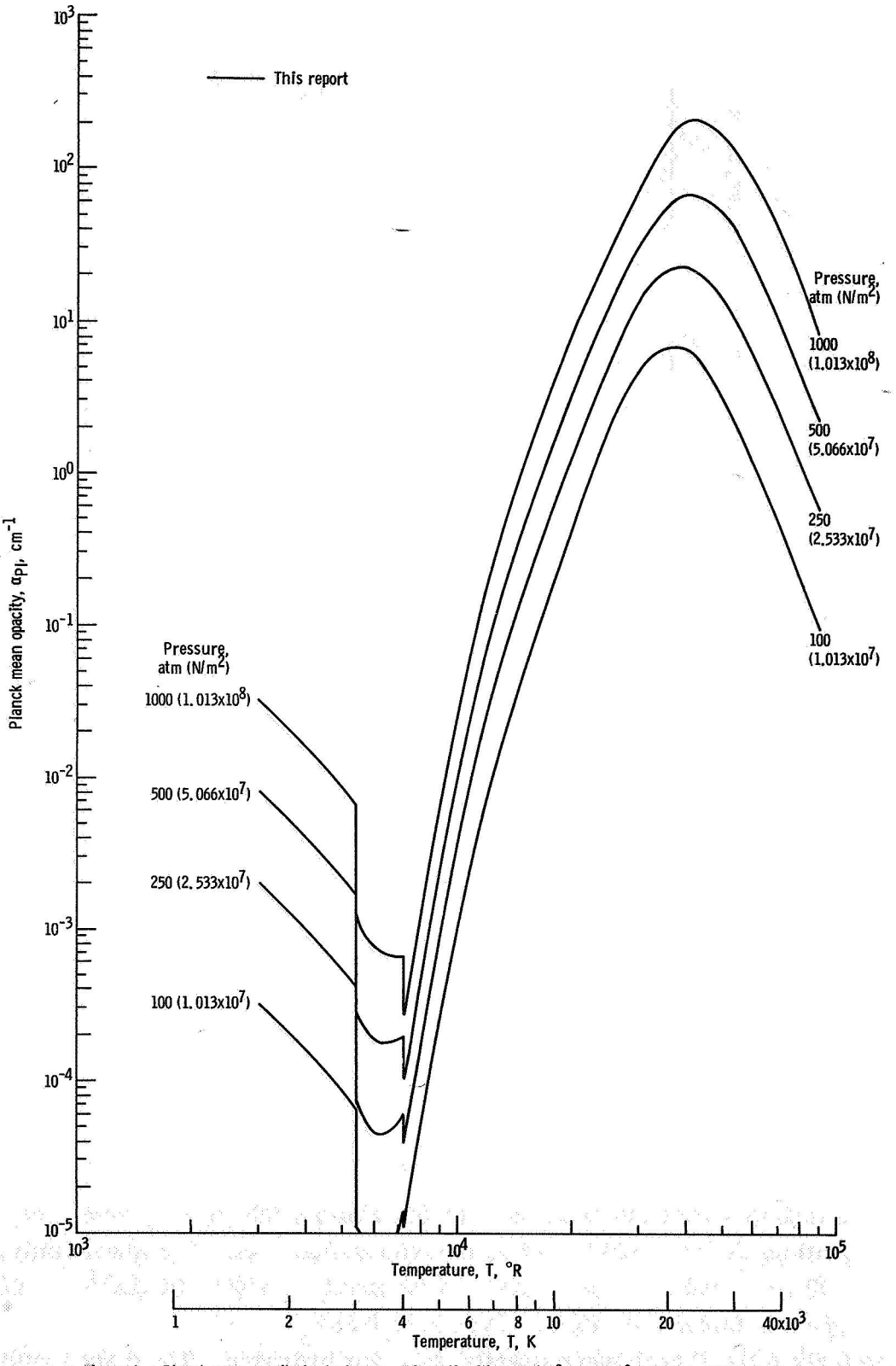


Figure 6. - Planck mean opacity for hydrogen. Discontinuities at 5400° and 7200° R (3000 and 4000 K) are due to lack of calculations for high temperatures for pressure-induced vibrational and rotational transitions, respectively.

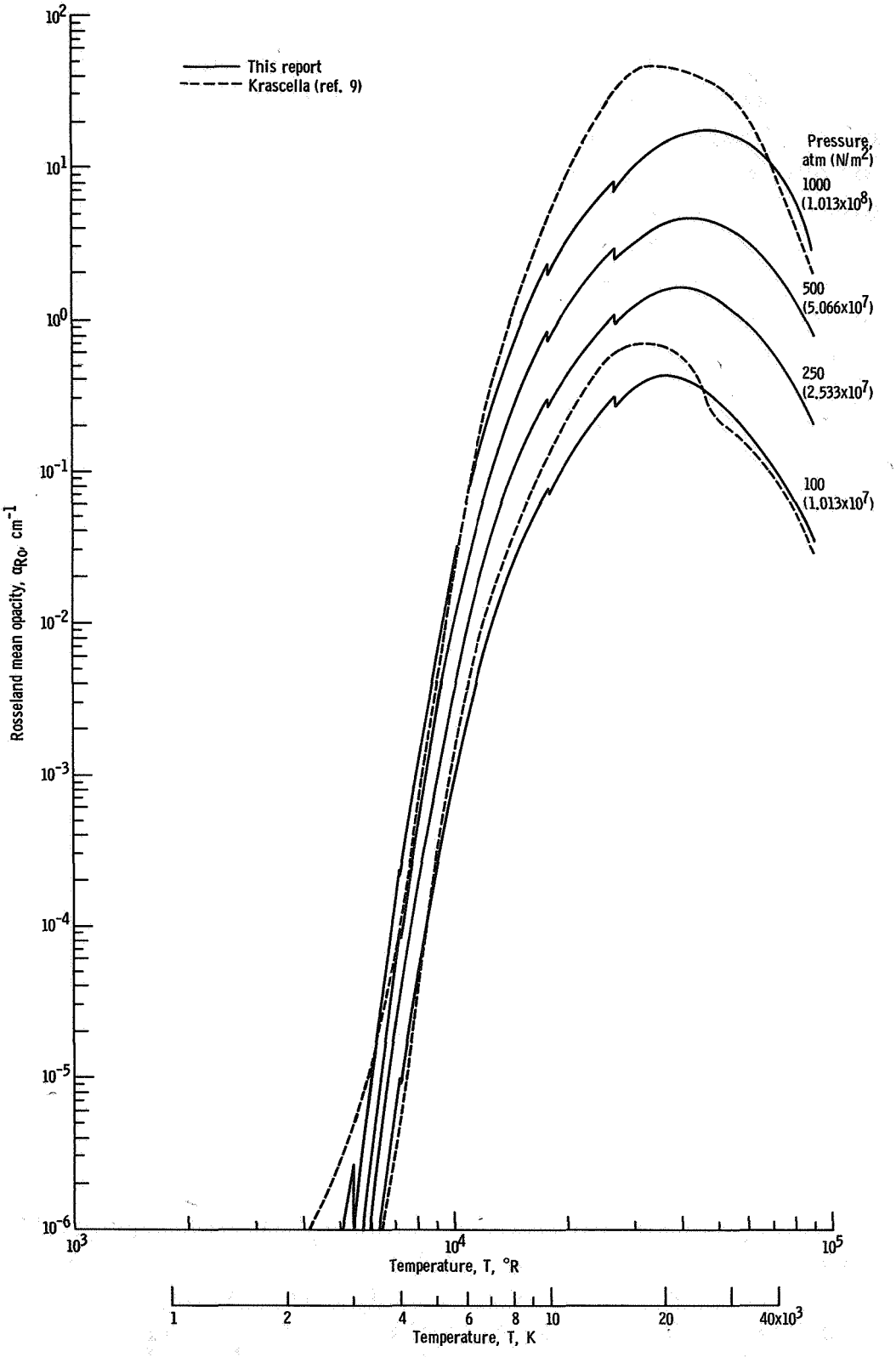


Figure 7. - Roseland mean opacity for hydrogen. The discontinuities in solid curves at 5400°, 7200°, 18 000°, and 27 000° R (3000, 4000, 10 000, and 15 000 K) are due to lack of calculations for high temperatures for pressure-induced vibrational, pressure-induced rotational, quasimolecular, and H_2^+ phogodissociation transitions, respectively. For comparison, Krascella's results are shown for 100 and 1000 atmospheres (1.013×10^7 and 1.013×10^8 N/m²).

rotational transitions. Lack of calculations for high temperatures for quasimolecular absorption and H_2^+ photodissociation did not cause discernible discontinuities because the Planck mean is most sensitive to peaks in $\alpha_{\tilde{\nu}}$ for photon wave numbers near where $B_{\tilde{\nu}}$ peaks. For temperatures below 5400° R (3000 K) the Planck mean opacity is proportional to the square of the pressure. For higher temperatures, the relation is more complicated.

The solid curves in figure 7 give the Rosseland mean opacity α_{Ro} for hydrogen. There is a discontinuity at 5400° R (3000 K) in the 1000 atm curve due to lack of calculations for pressure-induced vibrational transitions at higher temperatures. The discontinuities at 5400° R in the other three solid curves occur below the bottom of the graph. All four solid curves have discontinuities at 7200°, 18 000°, and 27 000° R (4000, 10 000, and 15 000 K) due to lack of calculations at high temperature for pressure-induced rotational, quasimolecular, and H_2^+ photodissociation transitions, respectively. The latter two discontinuities are discernible because the Rosseland mean opacity is most sensitive to valleys (or "windows") in $\alpha_{\tilde{\nu}}$.

The Armstrong bound (ref. 26) states that α_{Pl} must be greater than or equal to $0.947\,\alpha_{Ro}$. For the cases in this report α_{Pl} was always greater than α_{Ro}. The ratio α_{Pl}/α_{Ro} had a maximum value of 2.5×10^8.

At temperatures up to 9000° R (5000 K), the opacities of hydrogen are so small that it would probably be necessary in a gaseous-core nuclear rocket to add something to the hydrogen to make it more opaque, thereby protecting chamber walls from excessive thermal radiation.

Comparison with Other Investigators

A comparison of Krascella's (ref. 9) spectral absorption coefficient with the one in this report is given in figure 3(a) for 1000 atm (1.013×10^8 N/m^2) and 5000° R (2778 K). For photon wave numbers less than 109 677 cm^{-1}, his $\alpha_{\tilde{\nu}}$ is almost entirely due to the Lyman α line of H. Unfortunately, his expression for the absorption of Lyman α is only believed to be valid from about 81 300 to 83 300 cm^{-1}. Well to the red of this the correct value is probably much less than Krascella's value. Krascella's $\alpha_{\tilde{\nu}}$ for photon wave numbers less than 10^4 cm^{-1} is too small because he neglected pressure-induced absorption. His $\alpha_{\tilde{\nu}}$ is essentially the same as the $\alpha_{\tilde{\nu}}$ values in this report for photon wave numbers between 109 677 and 211 400 cm^{-1}. For greater photon wave numbers Krascella's $\alpha_{\tilde{\nu}}$ is too low because he neglected H_2 photoionization.

A similar comparison of $\alpha_{\tilde{\nu}}$ with Krascella's results is given in figure 3(b) for 70 000° R (38 889 K). For photon wave numbers less than 3000 cm^{-1}, the differences are primarily due to the inclusion of n in equation (12) of this report but not in refer-

ence 9. For photon wave numbers greater than 3000 cm^{-1}, the differences are principally due to the erroneous equation of state used by Krascella. This is discussed in reference 15.

A comparison of Krascella's α_{Ro} with the one in this report is given in figure 7. For temperatures greater than 15 000° R (8333 K), the differences are primarily due to differences in equations of state. For temperatures less than 6000° R (3333 K), the differences are due to the factors discussed above for figure 3(a), except that H_2 photoionization has no appreciable effect.

Additional comparisons with Krascella's work may be made by direct comparison of tables XIII to XVIII of reference 9 with tables II to VII of this report because they are for the same temperatures, pressures, and photon wave numbers.

Values of $\alpha_{\tilde{\nu}}$ calculated by the procedure in this report are in good agreement with values from Mastrup (ref. 6) for 10 080 K and 1 atm (1.013×10^5 N/m^2) pressure.

A comparison with Lasher et al. (ref. 10) is difficult because they have included atomic lines and have neglected H^- photodetachment and inverse bremsstrahlung, thereby causing their continuum absorption coefficients to be too low at 10 000 K and slightly higher temperatures. However, a comparison of their figures 6 to 8 shows that the continuum intensity becomes larger relative to the line intensity as pressure is increased. Consequently, for the pressures of 100 to 1000 atm (1.013×10^7 to 1.013×10^8 N/m^2) included in this report, the neglect of lines is not as serious as might be suspected, although the resulting error is undoubtedly appreciable. Even for 10 atm (1.013×10^6 N/m^2) pressure, Lasher et al. (ref. 10) point out that the validity of the Lyman line shapes is questionable far from the line centers. At higher pressures this situation is aggravated, which is why lines were neglected here.

Need for More Work

It is clear that for many conditions the $\alpha_{\tilde{\nu}}$ in this report is not accurate to within a factor of 2 and that the accuracy of α_{Pl} and α_{Ro} is thereby degraded. To remedy this, additional calculations are needed for a number of processes. Accurate line shapes should be derived so that atomic lines can be included with confidence. Calculations for higher temperatures for H_2-H_2 pressure-induced vibrational transitions are needed. There are no calculations for H_2-H pressure-induced vibrational transitions, although this process is probably important around photon wave numbers of 4000 cm^{-1} when dissociation of H_2 is appreciable. Calculations for higher temperatures and photon wave numbers for quasimolecular transitions are needed. The Lyman and Werner electronic transitions of H_2 (refs. 27 and 28) would probably be important if thermal radiation from a hot source was incident upon hydrogen containing appreciable H_2, as in a gaseous-core

nuclear rocket. The empirical treatment of H_2 photodissociation and photoionization should be replaced with a theoretical treatment so temperature effects could be included. After all these refinements, it is not clear if H_2^+ photodissociation would still be of any importance. Calculations for higher temperatures for H_2-H_2 pressure-induced translational and rotational transitions should have low priority because their small wave numbers correspond to regions of small radiant heat transfer in gaseous-core nuclear rockets.

CONCLUDING REMARKS

The spectral absorption coefficient, Planck mean opacity, and Rosseland mean opacity for hydrogen were calculated including 15 photon absorption processes. The treatment included H_3^+ in the composition as well as deviations of the real index of refraction from 1 near the plasma wave number. Both caused significant effects on the spectral absorption coefficient. The spectral absorption coefficient and Rosseland mean opacity were significantly different than the results of Krascella (ref. 9). However, at temperatures up to 9000° R (5000 K) the calculated opacities of hydrogen are still so small that it would probably be necessary in a gaseous-core nuclear rocket to add something to the hydrogen to make it more opaque, thereby protecting chamber walls from excessive thermal radiation.

Unfortunately, calculations for some of the 15 processes considered were not available for some photon wave numbers and temperatures. This caused inaccuracies and large discontinuities in the spectral absorption coefficient and Planck and Rosseland mean opacities. This situation should be corrected and some additional photon absorption processes (especially atomic lines) should be included in the calculation of the spectral absorption coefficient and opacities in order to obtain more reliable results.

Lewis Research Center,
National Aeronautics and Space Administration,
Cleveland, Ohio, July 28, 1969,
122-28.

APPENDIX A

SYMBOLS

a	parameter in numerical fit to pressure-induced absorption coefficient
a_o	first Bohr radius of hydrogen atom
$a_{\tilde{\nu}}$	spectral linear absorption coefficient at photon wave number $\tilde{\nu}$ excluding stimulated emission factor
B	integrated Planck function (also called integrated blackbody intensity) (see ref. 29)
$B_{\tilde{\nu}}$	Planck (or blackbody) function at wave number $\tilde{\nu}$ (see ref. 29)
B_ω	Planck (or blackbody) function at angular velocity ω
b	parameter in numerical fit to pressure-induced absorption coefficient
C	parameter in numerical fit to pressure-induced absorption coefficient
c	velocity of light in vacuum
d	parameter in numerical fit to pressure-induced absorption coefficient
e	charge of electron
$\vec{F}$	radiant heat flux
$\vec{F}_{\tilde{\nu}}$	radiant heat flux per unit photon wave number at photon wave number $\tilde{\nu}$
f	constant in numerical fit for H_2^+ absorption coefficient
$\overline{G}$	Gaunt factor for bremsstrahlung averaged over the electron velocity distribution
h	Planck's constant
$\hbar$	$h/2\pi$
I	integrated intensity (see ref. 29)
$I_{\tilde{\nu}}$	specific intensity at photon wave number $\tilde{\nu}$ (see ref. 29)
I_ω	specific intensity at angular velocity ω
i	$\sqrt{-1}$
$\vec{j}$	unit vector in x direction
K_T	complex dielectric coefficient for transverse electromagnetic waves
k	Boltzmann constant
k_f	final wave number of free electron
k_i	initial wave number of free electron

$k_{\tilde{\nu}}$	quasimolecular absorption coefficient excluding stimulated emission factor and given in ref. 20
L	plasma thickness
m	mass of electron
$N_i (i = 1, 2 \ldots 7)$	number density of species i
N_o	Loschmidt number
n	real index of refraction
$\mathscr{R}e$	operator which takes real part of complex number
S	distance along a ray
T	temperature
v_i	initial velocity of free electron
x	distance from point A measured in direction of ∇T
α	fine structure constant
α'	parameter in numerical fit to pressure-induced vibrational absorption coefficient
α_{Pl}	Planck mean opacity
α_{Ro}	Rosseland mean opacity
$\alpha_{\tilde{\nu}}$	spectral linear absorption coefficient at photon wave number $\tilde{\nu}$ including stimulated emission factor
Δk^2	$k_f^2 - k_i^2$
δ	parameter in numerical fit to pressure-induced vibrational absorption coefficient
ϵ_o	electric permittivity of free space
η_o	exchange phase shift
θ	5040^o K/T
κ	absorption coefficient for H_2^+ photodissociation and inverse bremsstrahlung collectively, including the stimulated emission factor and given in ref. 23
$\kappa_{\tilde{\nu}}$	absorption coefficient for pressure-induced absorption given in ref. 21
λ	wavelength
$\nu_{e,i} (i = 31, 32, 34, 36, 37)$	effective collision frequency of free electrons for collisions of type i

$\nu_{e,t}$	total effective collision frequency of free electrons
$\tilde{\nu}$	photon wave number
$\tilde{\nu}_c$	parameter in numerical fit to pressure-induced translational absorption coefficient
$\tilde{\nu}_o$	parameter in numerical fit to pressure-induced rotational absorption coefficient
$\tilde{\nu}_p$	$\omega_p/2\pi c$
$\tilde{\nu}_0$	fundamental vibrational frequency of ground electronic state of H_2
$\rho_i (i = 1, 2 \ldots 7)$	dimensionless density of species i, N_i/N_o
σ	sum of cross sections for photodissociation and photoionization of ground electronic state of H_2 including stimulated emission factor
$\tau_{\tilde{\nu}}$	optical depth at photon wave number $\tilde{\nu}$
τ_ω	optical depth at angular velocity ω
ϕ	angle between light ray and x axis
$\psi_i (i = III, X)$	function for finding limiting absorption coefficient for small photon wave number for process i
Ω	solid angle
ω_p	electron plasma frequency

Subscripts:

A	point A
Roman	any Roman numeral I to XI
1	hydrogen atom, H
2	proton, H^+
3	free electron, e^-
4	hydrogen molecule, H_2
5	negative hydrogen ion, H^-
6	hydrogen diatomic molecular ion, H_2^+
7	hydrogen triatomic molecular ion, H_3^+
31	e^--H collisions (H in ground state)
32	e^--H^+ collisions

34 e^--H_2 collisions (H_2 in ground electronic state)

36 e^--H_2^+ collisions

37 e^--H_3^+ collisions

I H photoionization

II H, H_2, and H_3 inverse bremsstrahlung collectively

III H^- inverse bremsstrahlung

IV H^- photodetachment

V H_2 photodissociation and photoionization collectively

VI H-H quasimolecular transition

VII H_2-H_2 pressure-induced translational transition

VIII H_2-H_2 pressure-induced rotational transition

IX H_2-H_2 pressure-induced vibrational transition

X H_2^- inverse bremsstrahlung

XI H_2^+ photodissociation and inverse bremsstrahlung collectively

‡ ground electronic state

APPENDIX B

PLANCK MEAN OPACITY FOR A NONSCATTERING PLASMA WITH REAL INDEX OF REFRACTION VARYING WITH PHOTON WAVE NUMBER

In this appendix the intensity emitted by a layer of plasma with varying real index of refraction is found in terms of the spectral absorption coefficient and other quantities. The Planck mean opacity for such a plasma is defined in terms of the emitted intensity. Combining these two expressions gives the Planck mean opacity in terms of the spectral absorption coefficient.

Consider a nonscattering, isotropic, homogeneous, isothermal, vertical layer of plasma of thickness L with a vacuum on either side. Assume no radiation is incident upon it from the left and neglect reflections at the boundaries. Bekefi (ref. 17) gives an expression (eq. (1.141)) for the specific intensity for one direction of polarization along a ray in the vacuum to the right of the layer and perpendicular to the boundaries. In deriving equation (1.141) Bekefi used the Rayleigh-Jeans approximation, which is unnecessary. The expression for two directions of polarization, local thermodynamic equilibrium, and no Rayleigh-Jeans approximation is obviously

$$I_\omega = B_\omega(1 - e^{-\tau_\omega}) \tag{B1}$$

where I_ω is the specific intensity per unit angular velocity, B_ω is the Planck function per unit angular velocity, and τ_ω is the optical thickness of the layer. The quantities I_ω and B_ω in this report are for two directions of polarization collectively. Note that equation (B1) is independent of the real index of refraction. The corresponding expression per unit photon wave number is

$$I_{\tilde{\nu}} = B_{\tilde{\nu}}(1 - e^{-\tau_{\tilde{\nu}}}) \tag{B2}$$

where

$$\tau_{\tilde{\nu}} = \tau_\omega = \alpha_{\tilde{\nu}} L \tag{B3}$$

The layer is assumed to be optically thin at all photon wave numbers ($\tau_{\tilde{\nu}} \ll 1$) so the exponential in equation (B2) can be expanded, with the result

$$I_{\tilde{\nu}} = B_{\tilde{\nu}} \alpha_{\tilde{\nu}} L \tag{B4}$$

Integrating equation (B4) over all photon wave numbers gives the integrated intensity

$$I = L \int_0^\infty B_{\tilde{\nu}} \alpha_{\tilde{\nu}} \, d\tilde{\nu} \tag{B5}$$

We define the Planck mean opacity α_{Pl} for a nonscattering plasma layer with varying real index of refraction by

$$I = LB\alpha_{Pl} \tag{B6}$$

where I is, as before, the integrated intensity in the vacuum to the right of the layer and along a ray perpendicular to the boundaries. The quantity B is the integrated Planck function. Equation (B6) is the same as customarily used for a nonscattering plasma layer with real index of refraction assumed to be 1.

Combining equations (B5) and (B6) gives

$$\alpha_{Pl} = \frac{\int_0^\infty B_{\tilde{\nu}} \alpha_{\tilde{\nu}} \, d\tilde{\nu}}{B} \tag{B7}$$

This is the desired relation for the Planck mean opacity in terms of the spectral absorption coefficient. The quantities B and $B_{\tilde{\nu}}$ are of course to be evaluated for the temperature of the plasma. Equation (B7) is identical to the customary expression for the Planck mean opacity for a nonscattering plasma with real index of refraction assumed to be 1.

APPENDIX C

ROSSELAND MEAN OPACITY FOR A NONSCATTERING PLASMA WITH REAL INDEX OF REFRACTION VARYING WITH PHOTON WAVE NUMBER

In this appendix the radiant flux for a plasma with varying real index of refraction is found for conditions where the diffusion approximation is valid (optically thick plasma with small temperature gradients). This radiant flux is given in terms of the spectral absorption coefficient and other quantities. The Rosseland mean opacity for such a plasma is defined in terms of the radiant flux and the temperature gradient. Combining these two expressions gives the Rosseland mean opacity in terms of the spectral absorption coefficient.

Consider a nonscattering, isotropic, infinite plasma with a small temperature gradient and with real index of refraction varying with angular velocity. For local thermodynamic equilibrium and two directions of polarization the transfer equation (ref. 17, eq. (1.136)) becomes

$$\frac{d}{d\tau_\omega}\left(\frac{I_\omega}{n^2}\right) = \frac{I_\omega}{n^2} - B_\omega \tag{C1}$$

where the optical depth τ_ω is defined by

$$d\tau_\omega = -\alpha_\omega \, dS \tag{C2}$$

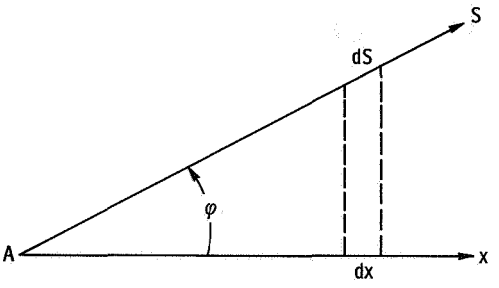
and is measured from some point A. Here S is the distance along a ray.

The quantities I_ω and B_ω in equation (C1) are per unit angular velocity. The corresponding equation per unit photon wave number is

$$\frac{d}{d\tau_{\tilde{\nu}}}\left(\frac{I_{\tilde{\nu}}}{n^2}\right) = \frac{I_{\tilde{\nu}}}{n^2} - B_{\tilde{\nu}} \tag{C3}$$

where $\tau_{\tilde{\nu}} = \tau_\omega$.

Let x be distance from point A measured in the direction of ∇T (and hence $\nabla B_{\tilde{\nu}}$). Assuming n independent of position, x and S are related as shown in the following sketch:



Consider radiation in the +S direction. The corresponding solution of equation (C3) is

$$\frac{I_{\tilde{\nu}}(A)}{n^2} = \int_0^{\infty} B_{\tilde{\nu}} e^{-\tau_{\tilde{\nu}}} d\tau_{\tilde{\nu}} \tag{C4}$$

The quantity $B_{\tilde{\nu}}$ may be expanded as a Taylor series about the point A and substituted into equation (C4) with the result

$$\frac{I_{\tilde{\nu}}(A)}{n^2} = B_{\tilde{\nu}}(A) + \left(\frac{\partial B_{\tilde{\nu}}}{\partial \tau_{\tilde{\nu}}}\right)_A + \ldots \tag{C5}$$

Retaining only the first two terms and substituting $d\tau_{\tilde{\nu}} = -\alpha_{\tilde{\nu}}\, dx/\cos\phi$ gives

$$\frac{I_{\tilde{\nu}}(A)}{n^2} = B_{\tilde{\nu}}(A) - \frac{\cos\phi}{\alpha_{\tilde{\nu}}} \nabla B_{\tilde{\nu}} \tag{C6}$$

Let $\vec{j}$ be a unit vector in the x direction. The spectral flux is given by the usual expression

$$\vec{F}_{\tilde{\nu}} = \vec{j} \int_{4\pi} I_{\tilde{\nu}}(A) \cos\phi \, d\Omega \tag{C7}$$

where $d\Omega$ is an element of solid angle about A. Substituting (C6) into (C7) gives

$$\vec{F}_{\tilde{\nu}} = -\frac{4\pi n^2}{3\alpha_{\tilde{\nu}}} \nabla B_{\tilde{\nu}} \tag{C8}$$

Integrating equation (C8) over all photon wave numbers gives

$$\vec{F} = -\frac{4\pi}{3}\int_0^\infty \frac{n^2}{\alpha_{\tilde{\nu}}}\frac{\partial B_{\tilde{\nu}}}{\partial T}\,d\tilde{\nu}\,\nabla T \tag{C9}$$

We define the Rosseland mean opacity α_{Ro} by the same equation as for plasmas with real index of refraction of 1, namely

$$\vec{F} = -\frac{4\pi}{3\alpha_{Ro}}\frac{dB}{dT}\nabla T \tag{C10}$$

Combining equations (C9) and (C10) gives

$$\alpha_{Ro} = \frac{\int_0^\infty \frac{\partial B_{\tilde{\nu}}}{\partial T}\,d\tilde{\nu}}{\int_0^\infty \frac{n^2}{\alpha_{\tilde{\nu}}}\frac{\partial B_{\tilde{\nu}}}{\partial T}\,d\tilde{\nu}} \tag{C11}$$

This is the desired relation for the Rosseland mean opacity in terms of the spectral absorption coefficient. Equation (C11) contains n^2, whereas the customary expression for α_{Ro} for a plasma with real index of refraction of 1 does not.

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TABLE I. - PHOTON WAVE NUMBERS AND TEMPERATURES

IN THIS REPORT FOR WHICH VARIOUS TRANSITIONS

WERE INCLUDED IN THE COMPUTER PROGRAM

Transition	Photon wave numbers, cm^{-1}	Temperature, K
H photoionization	All	All
H inverse bremsstrahlung[a]	All	2000 to 50 000
H_2 inverse bremsstrahlung[a]	All	2000 to 50 000
H_3 inverse bremsstrahlung[a]	All	All
H^- inverse bremsstrahlung[a]	All	All
H^- photodetachment	6583 to 109 679	All
H_2 photodissociation and photoionization	118 257 to 400 000	All
H-H quasimolecular	14 999 to 64 935	1667 to 10 000
H_2-H_2 pressure-induced translational	500 to 2000	1667 to 3000
H_2-H_2 pressure-induced rotational	All	1667 to 4000
H_2-H_2 pressure-induced vibrational	All	1667 to 3000
H_2^- inverse bremsstrahlung[a]	All	All
H_2^+ photodissociation and inverse bremsstrahlung[a]	500 to 25 000 25 000 to 118 260	2500 to 12 000 5000 to 15 000

[a]Inverse bremsstrahlung is referred to by the particle that results if the two free particles were to recombine. Hence H inverse bremsstrahlung involves H^+ and e, and similarly for H_2, H_3, H^-, and H_2^- inverse bremsstrahlung. However, H_2^+ inverse bremsstrahlung involves H and H^+.

TABLE II. - ABSORPTION COEFFICIENTS AND OPACITY OF HYDROGEN

AT 100 ATMOSPHERES (1.013×10^7 N/m^2) PRESSURE[a]

(a) Temperature, 3000° R (1667 K)

PRESSURE	0.1013E 08 N/M2	TOTAL NUMBER DENSITY	0.4404E 27 1/M3
TEMPERATURE	3000. R	H IONIZATION POTENTIAL	109679. 1/CM
TEMPERATURE	1667. K	PLANCK MEAN OPACITY	0.3280E-03 1/CM
DENSITY	0.1474E-02 G/CM3	ROSSELAND MEAN OPACITY	0.2432E-11 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	4.699E 21	H2(EXCITED STATES)	0.
H(EXCITED STATES)	2.716E-09	H-	5.786E 05
H+	0.	H2+	0.
E	3.770E 08	H3+	3.775E 08
H2(GROUND STATE)	4.404E 26		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.4068E-03	11000.	0.5486E-07	70000.	0.6516E-17
1500.	0.5885E-03	12000.	0.1069E-07	75000.	0.5760E-17
2000.	0.3700E-03	13500.	0.9070E-09	80000.	0.5134E-17
2500.	0.1320E-03	15000.	0.7603E-10	90000.	0.4196E-17
3000.	0.1168E-03	20000.	0.1844E-13	100000.	0.3486E-17
4000.	0.6876E-03	25000.	0.3740E-16	125000.	0.2412E 04
5000.	0.5568E-03	27500.	0.2897E-16	150000.	0.3700E 04
5500.	0.3607E-03	30000.	0.2543E-16	175000.	0.2533E 04
6000.	0.1649E-03	40000.	0.3604E-16	200000.	0.1938E 04
8000.	0.7009E-05	50000.	0.2312E-13	300000.	0.5897E 03
10000.	0.2793E-06	60000.	0.4207E-11	400000.	0.2258E 03

(b) Temperature, 5000° R (2778 K)

PRESSURE	0.1013E 08 N/M2	TOTAL NUMBER DENSITY	0.2642E 27 1/M3
TEMPERATURE	5000. R	H IONIZATION POTENTIAL	109679. 1/CM
TEMPERATURE	2778. K	PLANCK MEAN OPACITY	0.8492E-04 1/CM
DENSITY	0.8810E-03 G/CM3	ROSSELAND MEAN OPACITY	0.2630E-07 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	1.983E 24	H2(EXCITED STATES)	1.072E 07
H(EXCITED STATES)	2.486E 06	H-	8.575E 13
H+	6.109E 10	H2+	4.504E 10
E	2.439E 15	H3+	2.525E 15
H2(GROUND STATE)	2.622E 26		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.1060E-03	11000.	0.2725E-06	70000.	0.4988E-09
1500.	0.1871E-03	12000.	0.8484E-07	75000.	0.4352E-09
2000.	0.1984E-03	13500.	0.1723E-07	80000.	0.3830E-09
2500.	0.1251E-03	15000.	0.5997E-08	90000.	0.3078E-09
3000.	0.1036E-03	20000.	0.3005E-08	100000.	0.2503E-09
4000.	0.2472E-03	25000.	0.2350E-08	125000.	0.1445E 04
5000.	0.2188E-03	27500.	0.2105E-08	150000.	0.2209E 04
5500.	0.1567E-03	30000.	0.1901E-08	175000.	0.1512E 04
6000.	0.9263E-04	40000.	0.3431E-08	200000.	0.1156E 04
8000.	0.9352E-05	50000.	0.1536E-06	300000.	0.3519E 03
10000.	0.8897E-06	60000.	0.4103E-05	400000.	0.1348E 03

[a] 2.447E25 means 2.447×10^{25}, etc. Wave numbers in table are photon wave numbers.

TABLE II. - Continued. ABSORPTION COEFFICIENTS AND OPACITY OF HYDROGEN AT 100 ATMOSPHERES (1.013×10^7 N/m^2) PRESSURE[a]

(c) Temperature, 7000° R (3889 K)

PRESSURE	0.1013E 08 N/M2	TOTAL NUMBER DENSITY	0.1887E 27 1/M3
TEMPERATURE	7000. R	H IONIZATION POTENTIAL	109673. 1/CM
TEMPERATURE	3889. K	PLANCK MEAN OPACITY	0.1057E-04 1/CM
DENSITY	0.5932E-03 G/CM3	ROSSELAND MEAN OPACITY	0.6211E-05 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	2.300E 25	H2(EXCITED STATES)	6.400E 12
H(EXCITED STATES)	5.635E 12	H-	1.878E 17
H+	1.678E 16	H2+	5.889E 15
E	1.915E 18	H3+	2.079E 18
H2(GROUND STATE)	1.657E 26		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.9102E-04	11000.	0.8635E-05	70000.	0.1071E-05
1500.	0.8420E-04	12000.	0.8784E-05	75000.	0.9336E-06
2000.	0.8588E-04	13500.	0.8609E-05	80000.	0.8212E-06
2500.	0.6587E-04	15000.	0.8171E-05	90000.	0.6595E-06
3000.	0.4924E-04	20000.	0.6380E-05	100000.	0.5358E-06
4000.	0.1356E-04	25000.	0.5035E-05	125000.	0.1008E 04
5000.	0.4608E-05	27500.	0.4539E-05	150000.	0.1454E 04
5500.	0.3001E-05	30000.	0.4162E-05	175000.	0.9934E 03
6000.	0.2112E-05	40000.	0.7323E-05	200000.	0.7572E 03
8000.	0.5712E-05	50000.	0.1068E-03	300000.	0.2309E 03
10000.	0.8156E-05	60000.	0.1167E-02	400000.	0.8894E 02

(d) Temperature, 10 000° R (5556 K)

PRESSURE	0.1013E 08 N/M2	TOTAL NUMBER DENSITY	0.1321E 27 1/M3
TEMPERATURE	10000. R	H IONIZATION POTENTIAL	109624. 1/CM
TEMPERATURE	5556. K	PLANCK MEAN OPACITY	0.1065E-02 1/CM
DENSITY	0.2971E-03 G/CM3	ROSSELAND MEAN OPACITY	0.9233E-03 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	8.670E 25	H2(EXCITED STATES)	5.222E 16
H(EXCITED STATES)	2.072E 17	H-	2.860E 19
H+	1.538E 20	H2+	2.759E 19
E	2.634E 20	H3+	1.106E 20
H2(GROUND STATE)	4.541E 25		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.1103E-01	11000.	0.1308E-02	70000.	0.2198E-03
1500.	0.4906E-02	12000.	0.1337E-02	75000.	0.2018E-03
2000.	0.2764E-02	13500.	0.1321E-02	80000.	0.1873E-03
2500.	0.1773E-02	15000.	0.1263E-02	90000.	0.1672E-03
3000.	0.1235E-02	20000.	0.1008E-02	100000.	0.1523E-03
4000.	0.7005E-03	25000.	0.8154E-03	125000.	0.6276E 03
5000.	0.4541E-03	27500.	0.7264E-03	150000.	0.6129E 03
5500.	0.3783E-03	30000.	0.6790E-03	175000.	0.4129E 03
6000.	0.3209E-03	40000.	0.9605E-03	200000.	0.3048E 03
8000.	0.8662E-03	50000.	0.5353E-02	300000.	0.9461E 02
10000.	0.1230E-02	60000.	0.2804E-01	400000.	0.3828E 02

[a]2.447E25 means 2.447×10^{25}, etc. Wave numbers in table are photon wave numbers.

TABLE II. - Continued. ABSORPTION COEFFICIENTS AND OPACITY OF HYDROGEN AT 100 ATMOSPHERES (1.013×10^7 N/m^2) PRESSURE[a]

(e) Temperature, 13 000° R (7222 K)

PRESSURE	0.1013E 08 N/M2	TOTAL NUMBER DENSITY	0.1016E 27 1/M3
TEMPERATURE	13000. R	H IONIZATION POTENTIAL	109439. 1/CM
TEMPERATURE	7222. K	PLANCK MEAN OPACITY	0.1541E-01 1/CM
DENSITY	0.1816E-03 G/CM3	ROSSELAND MEAN OPACITY	0.1198E-01 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	9.469E 25	H2(EXCITED STATES)	2.958E 18
H(EXCITED STATES)	3.493E 19	H-	3.856E 20
H+	6.822E 21	H2+	4.437E 20
E	6.989E 21	H3+	1.085E 20
H2(GROUND STATE)	6.918E 24		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.2714E 00	11000.	0.1822E-01	70000.	0.3153E-02
1500.	0.1209E 00	12000.	0.1862E-01	75000.	0.2891E-02
2000.	0.6824E-01	13500.	0.1837E-01	80000.	0.2678E-02
2500.	0.4389E-01	15000.	0.1761E-01	90000.	0.2378E-02
3000.	0.3067E-01	20000.	0.1421E-01	100000.	0.2153E-02
4000.	0.1754E-01	25000.	0.1155E-01	125000.	0.4517E 03
5000.	0.1149E-01	27500.	0.1037E-01	150000.	0.3108E 03
5500.	0.9627E-02	30000.	0.9480E-02	175000.	0.2055E 03
6000.	0.8211E-02	40000.	0.8238E-02	200000.	0.1450E 03
8000.	0.1330E-01	50000.	0.1599E-01	300000.	0.4617E 02
10000.	0.1732E-01	60000.	0.4524E-01	400000.	0.1992E 02

(f) Temperature, 16 000° R (8889 K)

PRESSURE	0.1013E 08 N/M2	TOTAL NUMBER DENSITY	0.8257E 26 1/M3
TEMPERATURE	16000. R	H IONIZATION POTENTIAL	109055. 1/CM
TEMPERATURE	8889. K	PLANCK MEAN OPACITY	0.7959E-01 1/CM
DENSITY	0.1405E-03 G/CM3	ROSSELAND MEAN OPACITY	0.4434E-01 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	8.099E 25	H2(EXCITED STATES)	2.413E 19
H(EXCITED STATES)	7.686E 20	H-	1.630E 21
H+	5.938E 22	H2+	1.668E 21
E	5.948E 22	H3+	6.761E 19
H2(GROUND STATE)	1.463E 24		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.1981E 01	11000.	0.8125E-01	70000.	0.1345E-01
1500.	0.8810E 00	12000.	0.8365E-01	75000.	0.1219E-01
2000.	0.4965E 00	13500.	0.8146E-01	80000.	0.1117E-01
2500.	0.3188E 00	15000.	0.7758E-01	90000.	0.9711E-02
3000.	0.2223E 00	20000.	0.6234E-01	100000.	0.8613E-02
4000.	0.1279E 00	25000.	0.5050E-01	125000.	0.3619E 03
5000.	0.8321E-01	27500.	0.5023E-01	150000.	0.2284E 03
5500.	0.6947E-01	30000.	0.4491E-01	175000.	0.1501E 03
6000.	0.5905E-01	40000.	0.3222E-01	200000.	0.1044E 03
8000.	0.6812E-01	50000.	0.3344E-01	300000.	0.3353E 02
10000.	0.7894E-01	60000.	0.5060E-01	400000.	0.1476E 02

[a] 2.447E25 means 2.447×10^{25}, etc. Wave numbers in table are photon wave numbers.

TABLE II. - Continued. ABSORPTION COEFFICIENTS AND OPACITY OF HYDROGEN AT 100 ATMOSPHERES (1.013×10^7 N/m^2) PRESSURE[a]

(g) Temperature, 20 000° R (11 111 K)

PRESSURE	0.1013E 08 N/M2	TOTAL NUMBER DENSITY	0.6608E 26 1/M3
TEMPERATURE	20000. R	H IONIZATION POTENTIAL	108266. 1/CM
TEMPERATURE	11111. K	PLANCK MEAN OPACITY	0.4322E 00 1/CM
DENSITY	0.1105E-03 G/CM3	ROSSELAND MEAN OPACITY	0.1120E 00 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	6.495E 25	H2(EXCITED STATES)	1.382E 20
H(EXCITED STATES)	1.152E 22	H-	4.972E 21
H+	3.870E 23	H2+	4.735E 21
E	3.868E 23	H3+	4.475E 19
H2(GROUND STATE)	3.326E 23		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.1211E 02	11000.	0.3302E 00	70000.	0.4587E-01
1500.	0.5347E 01	12000.	0.3155E 00	75000.	0.4100E-01
2000.	0.2995E 01	13500.	0.2935E 00	80000.	0.3706E-01
2500.	0.1912E 01	15000.	0.2717E 00	90000.	0.3140E-01
3000.	0.1385E 01	20000.	0.2092E 00	100000.	0.2723E-01
4000.	0.7784E 00	25000.	0.1660E 00	125000.	0.2857E 03
5000.	0.4998E 00	27500.	0.2198E 00	150000.	0.1761E 03
5500.	0.4602E 00	30000.	0.1895E 00	175000.	0.1156E 03
6000.	0.3875E 00	40000.	0.1158E 00	200000.	0.8006E 02
8000.	0.3081E 00	50000.	0.8011E-01	300000.	0.2576E 02
10000.	0.2956E 00	60000.	0.5931E-01	400000.	0.1140E 02

(h) Temperature, 23 000° R (12 778 K)

PRESSURE	0.1013E 08 N/M2	TOTAL NUMBER DENSITY	0.5752E 26 1/M3
TEMPERATURE	23000. R	H IONIZATION POTENTIAL	107534. 1/CM
TEMPERATURE	12778. K	PLANCK MEAN OPACITY	0.1151E 01 1/CM
DENSITY	0.9479E-04 G/CM3	ROSSELAND MEAN OPACITY	0.1873E 00 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	5.526E 25	H2(EXCITED STATES)	3.280E 20
H(EXCITED STATES)	4.789E 22	H-	8.224E 21
H+	1.031E 24	H2+	7.660E 21
E	1.030E 24	H3+	3.567E 19
H2(GROUND STATE)	1.412E 23		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.3594E 02	11000.	0.7355E 00	70000.	0.8845E-01
1500.	0.1564E 02	12000.	0.6685E 00	75000.	0.7812E-01
2000.	0.8679E 01	13500.	0.5872E 00	80000.	0.6983E-01
2500.	0.5920E 01	15000.	0.5210E 00	90000.	0.5794E-01
3000.	0.4073E 01	20000.	0.3666E 00	100000.	0.4937E-01
4000.	0.2250E 01	25000.	0.2754E 00	125000.	0.2423E 03
5000.	0.1661E 01	27500.	0.5222E 00	150000.	0.1486E 03
5500.	0.1361E 01	30000.	0.4402E 00	175000.	0.9749E 02
6000.	0.1133E 01	40000.	0.2508E 00	200000.	0.6749E 02
8000.	0.7478E 00	50000.	0.1648E 00	300000.	0.2173E 02
10000.	0.6122E 00	60000.	0.1176E 00	400000.	0.9630E 01

[a] 2.447E25 means 2.447×10^{25}, etc. Wave numbers in table are photon wave numbers.

TABLE II. - Continued. ABSORPTION COEFFICIENTS AND OPACITY OF HYDROGEN AT 100 ATMOSPHERES (1.013×10^7 N/m^2) PRESSURE[a]

(i) Temperature, 26 000° R (14 444 K)

PRESSURE	0.1013E 08 N/M2	TOTAL NUMBER DENSITY	0.5102E 26 1/M3
TEMPERATURE	26000. R	H IONIZATION POTENTIAL	106758. 1/CM
TEMPERATURE	14444. K	PLANCK MEAN OPACITY	0.2476E 01 1/CM
DENSITY	0.8189E-04 G/CM3	ROSSELAND MEAN OPACITY	0.2794E 00 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	4.646E 25	H2(EXCITED STATES)	5.932E 20
H(EXCITED STATES)	1.422E 23	H-	1.115E 22
H+	2.165E 24	H2+	1.029E 22
E	2.164E 24	H3+	2.795E 19
H2(GROUND STATE)	6.626E 22		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.9362E 02	11000.	0.1556E 01	70000.	0.1471E 00
1500.	0.4290E 02	12000.	0.1360E 01	75000.	0.1283E 00
2000.	0.2364E 02	13500.	0.1137E 01	80000.	0.1134E 00
2500.	0.1490E 02	15000.	0.9693E 00	90000.	0.9198E-01
3000.	0.1020E 02	20000.	0.6255E 00	100000.	0.7688E-01
4000.	0.6721E 01	25000.	0.1260E 01	125000.	0.2034E 03
5000.	0.4208E 01	27500.	0.1045E 01	150000.	0.1245E 03
5500.	0.3439E 01	30000.	0.8663E 00	175000.	0.8168E 02
6000.	0.2857E 01	40000.	0.4664E 00	200000.	0.5652E 02
8000.	0.1702E 01	50000.	0.2925E 00	300000.	0.1820E 02
10000.	0.1811E 01	60000.	0.2011E 00	400000.	0.8071E 01

(j) Temperature, 30 000° R (16 667 K)

PRESSURE	0.1013E 08 N/M2	TOTAL NUMBER DENSITY	0.4454E 26 1/M3
TEMPERATURE	30000. R	H IONIZATION POTENTIAL	105786. 1/CM
TEMPERATURE	16667. K	PLANCK MEAN OPACITY	0.4715E 01 1/CM
DENSITY	0.6715E-04 G/CM3	ROSSELAND MEAN OPACITY	0.3440E 00 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	3.524E 25	H2(EXCITED STATES)	7.885E 20
H(EXCITED STATES)	3.514E 23	H-	1.291E 22
H+	4.448E 24	H2+	1.186E 22
E	4.447E 24	H3+	1.767E 19
H2(GROUND STATE)	2.492E 22		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.3114E 03	11000.	0.3453E 01	70000.	0.2128E 00
1500.	0.1159E 03	12000.	0.2923E 01	75000.	0.1792E 00
2000.	0.6239E 02	13500.	0.2337E 01	80000.	0.1527E 00
2500.	0.3888E 02	15000.	0.1915E 01	90000.	0.1149E 00
3000.	0.3167E 02	20000.	0.1115E 01	100000.	0.8894E-01
4000.	0.1736E 02	25000.	0.2514E 01	125000.	0.1542E 03
5000.	0.1082E 02	27500.	0.2016E 01	150000.	0.9426E 02
5500.	0.8827E 01	30000.	0.1646E 01	175000.	0.6181E 02
6000.	0.7321E 01	40000.	0.8297E 00	200000.	0.4276E 02
8000.	0.4082E 01	50000.	0.4855E 00	300000.	0.1377E 02
10000.	0.4152E 01	60000.	0.3117E 00	400000.	0.6109E 01

[a] 2.447E25 means 2.447×10^{25}, etc. Wave numbers in table are photon wave numbers.

TABLE II. - Continued. ABSORPTION COEFFICIENTS AND OPACITY OF HYDROGEN AT 100 ATMOSPHERES (1.013×10^7 N/m^2) PRESSURE[a]

(k) Temperature, 40 000° R (22 222 K)

PRESSURE	0.1013E 08 N/M2	TOTAL NUMBER DENSITY	0.3422E 26 1/M3
TEMPERATURE	40000. R	H IONIZATION POTENTIAL	104475. 1/CM
TEMPERATURE	22222. K	PLANCK MEAN OPACITY	0.6658E 01 1/CM
DENSITY	0.3951E-04 G/CM3	ROSSELAND MEAN OPACITY	0.4260E 00 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	1.222E 25	H2(EXCITED STATES)	3.031E 20
H(EXCITED STATES)	7.451E 23	H-	5.072E 21
H+	1.062E 25	H2+	5.622E 21
E	1.062E 25	H3+	1.781E 18
H2(GROUND STATE)	1.448E 21		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.2336E 04	11000.	0.8241E 01	70000.	0.3271E 00
1500.	0.4001E 03	12000.	0.6813E 01	75000.	0.2711E 00
2000.	0.2190E 03	13500.	0.5254E 01	80000.	0.2274E 00
2500.	0.1334E 03	15000.	0.4154E 01	90000.	0.1652E 00
3000.	0.8990E 02	20000.	0.2162E 01	100000.	0.1241E 00
4000.	0.4857E 02	25000.	0.4583E 01	125000.	0.5347E 02
5000.	0.3012E 02	27500.	0.3650E 01	150000.	0.3266E 02
5500.	0.2453E 02	30000.	0.2954E 01	175000.	0.2142E 02
6000.	0.2032E 02	40000.	0.1436E 01	200000.	0.1481E 02
8000.	0.1636E 02	50000.	0.8048E 00	300000.	0.4772E 01
10000.	0.1014E 02	60000.	0.4960E 00	400000.	0.2117E 01

(l) Temperature, 50 000° R (27 778 K)

PRESSURE	0.1013E 08 N/M2	TOTAL NUMBER DENSITY	0.2744E 26 1/M3
TEMPERATURE	50000. R	H IONIZATION POTENTIAL	104743. 1/CM
TEMPERATURE	27778. K	PLANCK MEAN OPACITY	0.3167E 01 1/CM
DENSITY	0.2593E-04 G/CM3	ROSSELAND MEAN OPACITY	0.2899E 00 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	2.902E 24	H2(EXCITED STATES)	3.953E 19
H(EXCITED STATES)	6.432E 23	H-	1.071E 21
H+	1.195E 25	H2+	1.003E 21
E	1.195E 25	H3+	4.878E 16
H2(GROUND STATE)	5.019E 19		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.3740E 04	11000.	0.6716E 01	70000.	0.2188E 00
1500.	0.3667E 03	12000.	0.5546E 01	75000.	0.1806E 00
2000.	0.1927E 03	13500.	0.4268E 01	80000.	0.1508E 00
2500.	0.1161E 03	15000.	0.3366E 01	90000.	0.1084E 00
3000.	0.7799E 02	20000.	0.1732E 01	100000.	0.8051E-01
4000.	0.4210E 02	25000.	0.3071E 01	125000.	0.1270E 02
5000.	0.2615E 02	27500.	0.2453E 01	150000.	0.7764E 01
5500.	0.2133E 02	30000.	0.1990E 01	175000.	0.5092E 01
6000.	0.1770E 02	40000.	0.9728E 00	200000.	0.3522E 01
8000.	0.1334E 02	50000.	0.5445E 00	300000.	0.1134E 01
10000.	0.8267E 01	60000.	0.3339E 00	400000.	0.5033E 00

[a] 2.447E25 means 2.447×10^{25}, etc. Wave numbers in table are photon wave numbers.

TABLE II. - Continued. ABSORPTION COEFFICIENTS AND OPACITY OF HYDROGEN AT 100 ATMOSPHERES (1.013×10^7 N/m^2) PRESSURE[a]

(m) Temperature, 60 000° R (33 333 K)

PRESSURE	0.1013E 08 N/M2	TOTAL NUMBER DENSITY	0.2268E 26 1/M3
TEMPERATURE	60000. R	H IONIZATION POTENTIAL	105405. 1/CM
TEMPERATURE	33333. K	PLANCK MEAN OPACITY	0.1169E 01 1/CM
DENSITY	0.1997E-04 G/CM3	ROSSELAND MEAN OPACITY	0.1759E 00 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	7.441E 23	H2(EXCITED STATES)	5.053E 18
H(EXCITED STATES)	4.413E 23	H-	1.781E 20
H+	1.075E 25	H2+	1.686E 20
E	1.075E 25	H3+	1.419E 15
H2(GROUND STATE)	2.293E 18		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.1564E 04	11000.	0.3993E 01	70000.	0.1186E 00
1500.	0.2175E 03	12000.	0.3304E 01	75000.	0.9806E-01
2000.	0.1056E 03	13500.	0.2550E 01	80000.	0.8198E-01
2500.	0.6358E 02	15000.	0.2017E 01	90000.	0.5893E-01
3000.	0.4758E 02	20000.	0.1047E 01	100000.	0.4373E-01
4000.	0.2583E 02	25000.	0.1593E 01	125000.	0.3260E 01
5000.	0.1612E 02	27500.	0.1278E 01	150000.	0.1996E 01
5500.	0.1317E 02	30000.	0.1041E 01	175000.	0.1310E 01
6000.	0.1095E 02	40000.	0.5161E 00	200000.	0.9061E 00
8000.	0.7883E 01	50000.	0.2918E 00	300000.	0.2918E 00
10000.	0.4904E 01	60000.	0.1802E 00	400000.	0.1295E 00

(n) Temperature, 70 000° R (38 889 K)

PRESSURE	0.1013E 08 N/M2	TOTAL NUMBER DENSITY	0.1930E 26 1/M3
TEMPERATURE	70000. R	H IONIZATION POTENTIAL	105984. 1/CM
TEMPERATURE	38889. K	PLANCK MEAN OPACITY	0.4620E 00 1/CM
DENSITY	0.1661E-04 G/CM3	ROSSELAND MEAN OPACITY	0.1078E 00 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	2.396E 23	H2(EXCITED STATES)	8.846E 17
H(EXCITED STATES)	3.141E 23	H-	3.819E 19
H+	9.373E 24	H2+	3.649E 19
E	9.373E 24	H3+	7.231E 13
H2(GROUND STATE)	1.777E 17		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.5541E 03	11000.	0.2371E 01	70000.	0.6664E-01
1500.	0.1274E 03	12000.	0.1965E 01	75000.	0.5526E-01
2000.	0.6370E 02	13500.	0.1521E 01	80000.	0.4630E-01
2500.	0.3875E 02	15000.	0.1207E 01	90000.	0.3341E-01
3000.	0.2612E 02	20000.	0.6322E 00	100000.	0.2485E-01
4000.	0.1569E 02	25000.	0.8530E 00	125000.	0.1050E 01
5000.	0.9825E 01	27500.	0.6868E 00	150000.	0.6445E 00
5500.	0.8042E 01	30000.	0.5617E 00	175000.	0.4235E 00
6000.	0.6696E 01	40000.	0.2823E 00	200000.	0.2931E 00
8000.	0.3638E 01	50000.	0.1614E 00	300000.	0.9441E-01
10000.	0.2906E 01	60000.	0.1006E 00	400000.	0.4188E-01

[a] 2.447E25 means 2.447×10^{25}, etc. Wave numbers in table are photon wave numbers.

TABLE II. - Concluded. ABSORPTION COEFFICIENTS AND OPACITY OF HYDROGEN AT 100 ATMOSPHERES (1.013×10^7 N/m^2) PRESSURE[a]

(o) Temperature, 80 000° R (44 444 K)

PRESSURE	0.1013E 08 N/M2	TOTAL NUMBER DENSITY	0.1680E 26 1/M3
TEMPERATURE	80000. R	H IONIZATION POTENTIAL	106439. 1/CM
TEMPERATURE	44444. K	PLANCK MEAN OPACITY	0.2020E 00 1/CM
DENSITY	0.1433E-04 G/CM3	ROSSELAND MEAN OPACITY	0.6299E-01 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	9.415E 22	H2(EXCITED STATES)	2.028E 17
H(EXCITED STATES)	2.324E 23	H-	1.049E 19
H+	8.238E 24	H2+	1.010E 19
E	8.238E 24	H3+	6.066E 12
H2(GROUND STATE)	2.153E 16		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.2713E 03	11000.	0.1458E 01	70000.	0.3986E-01
1500.	0.7768E 02	12000.	0.1210E 01	75000.	0.3315E-01
2000.	0.3959E 02	13500.	0.9392E 00	80000.	0.2785E-01
2500.	0.2425E 02	15000.	0.7468E 00	90000.	0.2019E-01
3000.	0.1641E 02	20000.	0.3943E 00	100000.	0.1507E-01
4000.	0.9788E 01	25000.	0.4885E 00	125000.	0.4123E 00
5000.	0.6147E 01	27500.	0.3945E 00	150000.	0.2540E 00
5500.	0.5037E 01	30000.	0.3236E 00	175000.	0.1672E 00
6000.	0.4199E 01	40000.	0.1645E 00	200000.	0.1158E 00
8000.	0.2291E 01	50000.	0.9505E-01	300000.	0.3732E-01
10000.	0.1784E 01	60000.	0.5972E-01	400000.	0.1655E-01

(p) Temperature, 90 000° R (50 000 K)

PRESSURE	0.1013E 08 N/M2	TOTAL NUMBER DENSITY	0.1488E 26 1/M3
TEMPERATURE	90000. R	H IONIZATION POTENTIAL	106797. 1/CM
TEMPERATURE	50000. K	PLANCK MEAN OPACITY	0.9655E-01 1/CM
DENSITY	0.1264E-04 G/CM3	ROSSELAND MEAN OPACITY	0.3450E-01 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	4.305E 22	H2(EXCITED STATES)	5.935E 16
H(EXCITED STATES)	1.780E 23	H-	3.497E 18
H+	7.330E 24	H2+	3.388E 18
E	7.330E 24	H3+	7.454E 11
H2(GROUND STATE)	3.655E 15		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.1577E 03	11000.	0.9456E 00	70000.	0.2537E-01
1500.	0.4853E 02	12000.	0.7863E 00	75000.	0.2116E-01
2000.	0.2593E 02	13500.	0.6112E 00	80000.	0.1782E-01
2500.	0.1597E 02	15000.	0.4869E 00	90000.	0.1298E-01
3000.	0.1084E 02	20000.	0.2587E 00	100000.	0.9724E-02
4000.	0.6427E 01	25000.	0.2993E 00	125000.	0.1882E 00
5000.	0.4044E 01	27500.	0.2424E 00	150000.	0.1164E 00
5500.	0.3317E 01	30000.	0.1993E 00	175000.	0.7680E-01
6000.	0.2767E 01	40000.	0.1023E 00	200000.	0.5327E-01
8000.	0.1515E 01	50000.	0.5963E-01	300000.	0.1719E-01
10000.	0.1156E 01	60000.	0.3775E-01	400000.	0.7621E-02

[a] 2.447E25 means 2.447×10^{25}, etc. Wave numbers in table are photon wave numbers.

TABLE III. - ABSORPTION COEFFICIENTS AND OPACITY OF HYDROGEN

AT 250 ATMOSPHERES (2.533×10^7 N/m^2) PRESSURE[a]

(a) Temperature, 3000° R (1667 K)

PRESSURE	0.2533E 08 N/M2	TOTAL NUMBER DENSITY	0.1101E 28 1/M3
TEMPERATURE	3000. R	H IONIZATION POTENTIAL	109679. 1/CM
TEMPERATURE	1667. K	PLANCK MEAN OPACITY	0.2050E-02 1/CM
DENSITY	0.3685E-02 G/CM3	ROSSELAND MEAN OPACITY	0.1169E-10 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	7.430E 21	H2(EXCITED STATES)	0.
H(EXCITED STATES)	4.294E-09	H-	1.818E 06
H+	0.	H2+	0.
E	7.491E 08	H3+	7.509E 08
H2(GROUND STATE)	1.101E 27		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.2543E-02	11000.	0.3429E-06	70000.	0.2643E-16
1500.	0.3678E-02	12000.	0.6679E-07	75000.	0.2344E-16
2000.	0.2312E-02	13500.	0.5669E-08	80000.	0.2095E-16
2500.	0.8252E-03	15000.	0.4752E-09	90000.	0.1719E-16
3000.	0.7300E-03	20000.	0.1152E-12	100000.	0.1435E-16
4000.	0.4297E-02	25000.	0.1635E-15	125000.	0.6029E 04
5000.	0.3480E-02	27500.	0.1192E-15	150000.	0.9250E 04
5500.	0.2254E-02	30000.	0.1039E-15	175000.	0.6332E 04
6000.	0.1031E-02	40000.	0.1154E-15	200000.	0.4845E 04
8000.	0.4381E-04	50000.	0.5781E-13	300000.	0.1474E 04
10000.	0.1746E-05	60000.	0.1052E-10	400000.	0.5644E 03

(b) Temperature, 5000° R (2778 K)

PRESSURE	0.2533E 08 N/M2	TOTAL NUMBER DENSITY	0.6606E 27 1/M3
TEMPERATURE	5000. R	H IONIZATION POTENTIAL	109679. 1/CM
TEMPERATURE	2778. K	PLANCK MEAN OPACITY	0.5337E-03 1/CM
DENSITY	0.2206E-02 G/CM3	ROSSELAND MEAN OPACITY	0.9769E-07 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	3.139E 24	H2(EXCITED STATES)	2.687E 07
H(EXCITED STATES)	3.937E 06	H-	2.679E 14
H+	4.903E 10	H2+	5.723E 10
E	4.812E 15	H3+	5.080E 15
H2(GROUND STATE)	6.574E 26		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.6658E-03	11000.	0.1700E-05	70000.	0.1587E-08
1500.	0.1176E-02	12000.	0.5204E-06	75000.	0.1386E-08
2000.	0.1247E-02	13500.	0.9578E-07	80000.	0.1220E-08
2500.	0.7865E-03	15000.	0.2584E-07	90000.	0.9809E-09
3000.	0.6513E-03	20000.	0.9665E-08	100000.	0.7982E-09
4000.	0.1553E-02	25000.	0.7512E-08	125000.	0.3614E 04
5000.	0.1375E-02	27500.	0.6717E-08	150000.	0.5532E 04
5500.	0.9851E-03	30000.	0.6053E-08	175000.	0.3786E 04
6000.	0.5822E-03	40000.	0.9457E-08	200000.	0.2897E 04
8000.	0.5877E-04	50000.	0.3856E-06	300000.	0.8816E 03
10000.	0.5580E-05	60000.	0.1029E-04	400000.	0.3376E 03

[a]Wave numbers in table are photon wave numbers.

TABLE III. - Continued. ABSORPTION COEFFICIENTS AND OPACITY OF HYDROGEN AT 250 ATMOSPHERES (2.533×10^7 N/m^2) PRESSURE[a]

(c) Temperature, 7000° R (3889 K)

PRESSURE	0.2533E 08 N/M2	TOTAL NUMBER DENSITY	0.4718E 27 1/M3
TEMPERATURE	7000. R	H IONIZATION POTENTIAL	109671. 1/CM
TEMPERATURE	3889. K	PLANCK MEAN OPACITY	0.5105E-04 1/CM
DENSITY	0.1517E-02 G/CM3	ROSSELAND MEAN OPACITY	0.2257E-04 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	3.725E 25	H2(EXCITED STATES)	1.677E 13
H(EXCITED STATES)	9.114E 12	H-	6.084E 17
H+	1.360E 16	H2+	9.038E 15
E	3.830E 18	H3+	4.416E 18
H2(GROUND STATE)	4.346E 26		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.4919E-03	11000.	0.2859E-04	70000.	0.3487E-05
1500.	0.5197E-03	12000.	0.2897E-04	75000.	0.3041E-05
2000.	0.5574E-03	13500.	0.2829E-04	80000.	0.2675E-05
2500.	0.4319E-03	15000.	0.2679E-04	90000.	0.2149E-05
3000.	0.3240E-03	20000.	0.2084E-04	100000.	0.1746E-05
4000.	0.8520E-04	25000.	0.1641E-04	125000.	0.2543E 04
5000.	0.2658E-04	27500.	0.1477E-04	150000.	0.3751E 04
5500.	0.1644E-04	30000.	0.1349E-04	175000.	0.2565E 04
6000.	0.1102E-04	40000.	0.2093E-04	200000.	0.1958E 04
8000.	0.1982E-04	50000.	0.2813E-03	300000.	0.5965E 03
10000.	0.2718E-04	60000.	0.3060E-02	400000.	0.2292E 03

(d) Temperature, 10 000° R (5556 K)

PRESSURE	0.2533E 08 N/M2	TOTAL NUMBER DENSITY	0.3303E 27 1/M3
TEMPERATURE	10000. R	H IONIZATION POTENTIAL	109600. 1/CM
TEMPERATURE	5556. K	PLANCK MEAN OPACITY	0.3943E-02 1/CM
DENSITY	0.8288E-03 G/CM3	ROSSELAND MEAN OPACITY	0.3394E-02 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	1.653E 26	H2(EXCITED STATES)	2.244E 17
H(EXCITED STATES)	3.905E 17	H-	1.045E 20
H+	1.540E 20	H2+	5.265E 19
E	5.047E 20	H3+	4.025E 20
H2(GROUND STATE)	1.650E 26		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.4718E-01	11000.	0.4785E-02	70000.	0.7066E-03
1500.	0.2096E-01	12000.	0.4883E-02	75000.	0.6354E-03
2000.	0.1178E-01	13500.	0.4813E-02	80000.	0.5776E-03
2500.	0.7540E-02	15000.	0.4592E-02	90000.	0.4960E-03
3000.	0.5236E-02	20000.	0.3636E-02	100000.	0.4344E-03
4000.	0.2948E-02	25000.	0.2918E-02	125000.	0.1626E 04
5000.	0.1891E-02	27500.	0.2626E-02	150000.	0.1827E 04
5500.	0.1566E-02	30000.	0.2447E-02	175000.	0.1238E 04
6000.	0.1320E-02	40000.	0.3445E-02	200000.	0.9262E 03
8000.	0.3226E-02	50000.	0.1939E-01	300000.	0.2854E 03
10000.	0.4513E-02	60000.	0.1018E 00	400000.	0.1132E 03

[a]Wave numbers in table are photon wave numbers.

TABLE III. - Continued. ABSORPTION COEFFICIENTS AND OPACITY OF HYDROGEN AT 250 ATMOSPHERES (2.533×10^7 N/m^2) PRESSURE[a]

(e) Temperature, 13 000° R (7222 K)

PRESSURE	0.2533E 08 N/M2	TOTAL NUMBER DENSITY	0.2541E 27 1/M3
TEMPERATURE	13000. R	H IONIZATION POTENTIAL	109367. 1/CM
TEMPERATURE	7222. K	PLANCK MEAN OPACITY	0.5561E-01 1/CM
DENSITY	0.4862E-03 G/CM3	ROSSELAND MEAN OPACITY	0.4423E-01 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	2.175E 26	H2(EXCITED STATES)	1.514E 19
H(EXCITED STATES)	7.720E 19	H-	1.398E 21
H+	1.007E 22	H2+	1.505E 21
E	1.103E 22	H3+	8.458E 20
H2(GROUND STATE)	3.651E 25		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.1028E 01	11000.	0.6617E-01	70000.	0.1120E-01
1500.	0.4577E 00	12000.	0.6748E-01	75000.	0.1024E-01
2000.	0.2582E 00	13500.	0.6655E-01	80000.	0.9471E-02
2500.	0.1660E 00	15000.	0.6375E-01	90000.	0.8381E-02
3000.	0.1159E 00	20000.	0.5138E-01	100000.	0.7559E-02
4000.	0.6617E-01	25000.	0.4181E-01	125000.	0.1151E 04
5000.	0.4319E-01	27500.	0.3723E-01	150000.	0.8872E 03
5500.	0.3612E-01	30000.	0.3428E-01	175000.	0.5905E 03
6000.	0.3076E-01	40000.	0.3253E-01	200000.	0.4239E 03
8000.	0.4863E-01	50000.	0.7607E-01	300000.	0.1337E 03
10000.	0.6299E-01	60000.	0.2321E 00	400000.	0.5634E 02

(f) Temperature, 16 000° R (8889 K)

PRESSURE	0.2533E 08 N/M2	TOTAL NUMBER DENSITY	0.2064E 27 1/M3
TEMPERATURE	16000. R	H IONIZATION POTENTIAL	108877. 1/CM
TEMPERATURE	8889. K	PLANCK MEAN OPACITY	0.2814E 00 1/CM
DENSITY	0.3599E-03 G/CM3	ROSSELAND MEAN OPACITY	0.1737E 00 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	1.975E 26	H2(EXCITED STATES)	1.338E 20
H(EXCITED STATES)	1.731E 21	H-	6.316E 21
H+	9.378E 22	H2+	6.426E 21
E	9.453E 22	H3+	5.352E 20
H2(GROUND STATE)	8.706E 24		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.7686E 01	11000.	0.3141E 00	70000.	0.5134E-01
1500.	0.3420E 01	12000.	0.3209E 00	75000.	0.4660E-01
2000.	0.1928E 01	13500.	0.3132E 00	80000.	0.4273E-01
2500.	0.1238E 01	15000.	0.2988E 00	90000.	0.3721E-01
3000.	0.8640E 00	20000.	0.2408E 00	100000.	0.3304E-01
4000.	0.4924E 00	25000.	0.1956E 00	125000.	0.9109E 03
5000.	0.3208E 00	27500.	0.1849E 00	150000.	0.6002E 03
5500.	0.2680E 00	30000.	0.1669E 00	175000.	0.3956E 03
6000.	0.2279E 00	40000.	0.1264E 00	200000.	0.2773E 03
8000.	0.2621E 00	50000.	0.1517E 00	300000.	0.8865E 02
10000.	0.3049E 00	60000.	0.2649E 00	400000.	0.3863E 02

[a]Wave numbers in table are photon wave numbers.

TABLE III. - Continued. ABSORPTION COEFFICIENTS AND OPACITY OF HYDROGEN AT 250 ATMOSPHERES (2.533×10^7 N/m^2) PRESSURE[a]

(g) Temperature, 20 000° R (11 111 K)

PRESSURE	0.2533E 08 N/M2	TOTAL NUMBER DENSITY	0.1652E 27 1/M3
TEMPERATURE	20000. R	H IONIZATION POTENTIAL	107863. 1/CM
TEMPERATURE	11111. K	PLANCK MEAN OPACITY	0.1326E 01 1/CM
DENSITY	0.2789E-03 G/CM3	ROSSELAND MEAN OPACITY	0.4184E 00 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	1.618E 26	H2(EXCITED STATES)	7.546E 20
H(EXCITED STATES)	2.498E 22	H-	2.006E 22
H+	6.270E 23	H2+	1.911E 22
E	6.265E 23	H3+	4.499E 20
H2(GROUND STATE)	2.064E 24		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.4584E 02	11000.	0.1231E 01	70000.	0.1757E 00
1500.	0.2027E 02	12000.	0.1191E 01	75000.	0.1577E 00
2000.	0.1138E 02	13500.	0.1123E 01	80000.	0.1431E 00
2500.	0.7274E 01	15000.	0.1050E 01	90000.	0.1222E 00
3000.	0.5074E 01	20000.	0.8224E 00	100000.	0.1065E 00
4000.	0.2866E 01	25000.	0.6582E 00	125000.	0.7185E 03
5000.	0.1849E 01	27500.	0.7557E 00	150000.	0.4491E 03
5500.	0.1651E 01	30000.	0.6610E 00	175000.	0.2950E 03
6000.	0.1395E 01	40000.	0.4207E 00	200000.	0.2049E 03
8000.	0.1157E 01	50000.	0.2986E 00	300000.	0.6584E 02
10000.	0.1142E 01	60000.	0.2247E 00	400000.	0.2904E 02

(h) Temperature, 23 000° R (12 778 K)

PRESSURE	0.2533E 08 N/M2	TOTAL NUMBER DENSITY	0.1438E 27 1/M3
TEMPERATURE	23000. R	H IONIZATION POTENTIAL	106912. 1/CM
TEMPERATURE	12778. K	PLANCK MEAN OPACITY	0.3353E 01 1/CM
DENSITY	0.2393E-03 G/CM3	ROSSELAND MEAN OPACITY	0.6928E 00 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	1.393E 26	H2(EXCITED STATES)	1.754E 21
H(EXCITED STATES)	1.011E 23	H-	3.409E 22
H+	1.695E 24	H2+	3.177E 22
E	1.693E 24	H3+	3.730E 20
H2(GROUND STATE)	8.978E 23		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.1303E 03	11000.	0.2557E 01	70000.	0.3319E 00
1500.	0.5664E 02	12000.	0.2372E 01	75000.	0.2954E 00
2000.	0.3188E 02	13500.	0.2135E 01	80000.	0.2659E 00
2500.	0.2023E 02	15000.	0.1930E 01	90000.	0.2234E 00
3000.	0.1394E 02	20000.	0.1410E 01	100000.	0.1923E 00
4000.	0.7735E 01	25000.	0.1941E 01	125000.	0.6138E 03
5000.	0.5511E 01	27500.	0.1688E 01	150000.	0.3793E 03
5500.	0.4526E 01	30000.	0.1447E 01	175000.	0.2489E 03
6000.	0.3780E 01	40000.	0.8686E 00	200000.	0.1725E 03
8000.	0.2624E 01	50000.	0.5921E 00	300000.	0.5551E 02
10000.	0.2780E 01	60000.	0.4332E 00	400000.	0.2456E 02

[a]Wave numbers in table are photon wave numbers.

TABLE III. - Continued. ABSORPTION COEFFICIENTS AND OPACITY OF HYDROGEN AT 250 ATMOSPHERES (2.533×10^7 N/m^2) PRESSURE[a]

(i) Temperature, 26 000° R (14 444 K)

PRESSURE	0.2533E 08 N/M2	TOTAL NUMBER DENSITY	0.1275E 27 1/M3
TEMPERATURE	26000. R	H IONIZATION POTENTIAL	105885. 1/CM
TEMPERATURE	14444. K	PLANCK MEAN OPACITY	0.6905E 01 1/CM
DENSITY	0.2081E-03 G/CM3	ROSSELAND MEAN OPACITY	0.1000E 01 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	1.194E 26	H2(EXCITED STATES)	3.158E 21
H(EXCITED STATES)	2.943E 23	H-	4.797E 22
H+	3.627E 24	H2+	4.428E 22
E	3.623E 24	H3+	3.093E 20
H2(GROUND STATE)	4.377E 23		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.3749E 03	11000.	0.5103E 01	70000.	0.5398E 00
1500.	0.1416E 03	12000.	0.4556E 01	75000.	0.4758E 00
2000.	0.7755E 02	13500.	0.3916E 01	80000.	0.4244E 00
2500.	0.4879E 02	15000.	0.3418E 01	90000.	0.3507E 00
3000.	0.3342E 02	20000.	0.2329E 01	100000.	0.2976E 00
4000.	0.2128E 02	25000.	0.3813E 01	125000.	0.5243E 03
5000.	0.1337E 02	27500.	0.3238E 01	150000.	0.3223E 03
5500.	0.1095E 02	30000.	0.2729E 01	175000.	0.2115E 03
6000.	0.9115E 01	40000.	0.1551E 01	200000.	0.1464E 03
8000.	0.5660E 01	50000.	0.1015E 01	300000.	0.4714E 02
10000.	0.5803E 01	60000.	0.7204E 00	400000.	0.2088E 02

(j) Temperature, 30 000° R (16 667 K)

PRESSURE	0.2533E 08 N/M2	TOTAL NUMBER DENSITY	0.1112E 27 1/M3
TEMPERATURE	30000. R	H IONIZATION POTENTIAL	104546. 1/CM
TEMPERATURE	16667. K	PLANCK MEAN OPACITY	0.1363E 02 1/CM
DENSITY	0.1737E-03 G/CM3	ROSSELAND MEAN OPACITY	0.1202E 01 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	9.478E 25	H2(EXCITED STATES)	4.588E 21
H(EXCITED STATES)	7.658E 23	H-	5.006E 22
H+	7.697E 24	H2+	5.522E 22
E	7.693E 24	H3+	2.212E 20
H2(GROUND STATE)	1.803E 23		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.1383E 04	11000.	0.1097E 02	70000.	0.7426E 00
1500.	0.4165E 03	12000.	0.9438E 01	75000.	0.6308E 00
2000.	0.2355E 03	13500.	0.7723E 01	80000.	0.5419E 00
2500.	0.1467E 03	15000.	0.6466E 01	90000.	0.4147E 00
3000.	0.1000E 03	20000.	0.3994E 01	100000.	0.3253E 00
4000.	0.5464E 02	25000.	0.7545E 01	125000.	0.4153E 03
5000.	0.3408E 02	27500.	0.6127E 01	150000.	0.2545E 03
5500.	0.2782E 02	30000.	0.5059E 01	175000.	0.1669E 03
6000.	0.2310E 02	40000.	0.2660E 01	200000.	0.1155E 03
8000.	0.1958E 02	50000.	0.1613E 01	300000.	0.3720E 02
10000.	0.1298E 02	60000.	0.1065E 01	400000.	0.1649E 02

[a]Wave numbers in table are photon wave numbers.

TABLE III. - Continued. ABSORPTION COEFFICIENTS AND OPACITY OF HYDROGEN AT 250 ATMOSPHERES (2.533×10^7 N/m^2) PRESSURE[a]

(k) Temperature, 40 000° R (22 222 K)

PRESSURE	0.2533E 08 N/M2	TOTAL NUMBER DENSITY	0.8591E 26 1/M3
TEMPERATURE	40000. R	H IONIZATION POTENTIAL	102347. 1/CM
TEMPERATURE	22222. K	PLANCK MEAN OPACITY	0.2332E 02 1/CM
DENSITY	0.1086E-03 G/CM3	ROSSELAND MEAN OPACITY	0.1670E 01 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	4.185E 25	H2(EXCITED STATES)	2.578E 21
H(EXCITED STATES)	1.851E 24	H-	4.122E 22
H+	2.105E 25	H2+	3.816E 22
E	2.105E 25	H3+	4.139E 19
H2(GROUND STATE)	1.698E 22		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.1189E 05	11000.	0.2994E 02	70000.	0.1268E 01
1500.	0.2919E 04	12000.	0.2487E 02	75000.	0.1058E 01
2000.	0.9828E 03	13500.	0.1933E 02	80000.	0.8930E 00
2500.	0.5451E 03	15000.	0.1541E 02	90000.	0.6581E 00
3000.	0.3488E 03	20000.	0.8252E 01	100000.	0.5004E 00
4000.	0.1827E 03	25000.	0.1635E 02	125000.	0.1832E 03
5000.	0.1586E 03	27500.	0.1309E 02	150000.	0.1119E 03
5500.	0.1298E 03	30000.	0.1065E 02	175000.	0.7341E 02
6000.	0.1080E 03	40000.	0.5281E 01	200000.	0.5078E 02
8000.	0.5886E 02	50000.	0.3019E 01	300000.	0.1636E 02
10000.	0.3667E 02	60000.	0.1894E 01	400000.	0.7258E 01

(l) Temperature, 50 000° R (27 778 K)

PRESSURE	0.2533E 08 N/M2	TOTAL NUMBER DENSITY	0.6956E 26 1/M3
TEMPERATURE	50000. R	H IONIZATION POTENTIAL	102229. 1/CM
TEMPERATURE	27778. K	PLANCK MEAN OPACITY	0.1482E 02 1/CM
DENSITY	0.7089E-04 G/CM3	ROSSELAND MEAN OPACITY	0.1394E 01 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	1.321E 25	H2(EXCITED STATES)	5.306E 20
H(EXCITED STATES)	1.907E 24	H-	1.110E 22
H+	2.721E 25	H2+	1.040E 22
E	2.721E 25	H3+	2.303E 18
H2(GROUND STATE)	1.040E 21		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.1492E 05	11000.	0.3142E 02	70000.	0.1044E 01
1500.	0.6501E 04	12000.	0.2596E 02	75000.	0.8644E 00
2000.	0.1261E 04	13500.	0.2000E 02	80000.	0.7240E 00
2500.	0.6464E 03	15000.	0.1579E 02	90000.	0.5237E 00
3000.	0.4079E 03	20000.	0.2359E 02	100000.	0.3913E 00
4000.	0.2084E 03	25000.	0.1420E 02	125000.	0.5785E 02
5000.	0.1698E 03	27500.	0.1136E 02	150000.	0.3536E 02
5500.	0.1388E 03	30000.	0.9234E 01	175000.	0.2319E 02
6000.	0.1154E 03	40000.	0.4545E 01	200000.	0.1604E 02
8000.	0.6258E 02	50000.	0.2563E 01	300000.	0.5167E 01
10000.	0.3868E 02	60000.	0.1583E 01	400000.	0.2293E 01

[a]Wave numbers in table are photon wave numbers.

TABLE III. - Continued. ABSORPTION COEFFICIENTS AND OPACITY OF HYDROGEN AT 250 ATMOSPHERES (2.533×10^7 N/m^2) PRESSURE[a]

(m) Temperature, 60 000° R (33 333 K)

PRESSURE	0.2533E 08 N/M2	TOTAL NUMBER DENSITY	0.5755E 26 1/M3
TEMPERATURE	60000. R	H IONIZATION POTENTIAL	103021. 1/CM
TEMPERATURE	33333. K	PLANCK MEAN OPACITY	0.6341E 01 1/CM
DENSITY	0.5265E-04 G/CM3	ROSSELAND MEAN OPACITY	0.9525E 00 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	3.955E 24	H2(EXCITED STATES)	8.279E 19
H(EXCITED STATES)	1.417E 24	H-	2.297E 21
H+	2.608E 25	H2+	2.175E 21
E	2.608E 25	H3+	9.729E 16
H2(GROUND STATE)	6.479E 19		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.1433E 05	11000.	0.2149E 02	70000.	0.6403E 00
1500.	0.4985E 04	12000.	0.1777E 02	75000.	0.5300E 00
2000.	0.8524E 03	13500.	0.1370E 02	80000.	0.4436E 00
2500.	0.4458E 03	15000.	0.1084E 02	90000.	0.3197E 00
3000.	0.2837E 03	20000.	0.5627E 01	100000.	0.2378E 00
4000.	0.1465E 03	25000.	0.8509E 01	125000.	0.1733E 02
5000.	0.8954E 02	27500.	0.6829E 01	150000.	0.1061E 02
5500.	0.7272E 02	30000.	0.5567E 01	175000.	0.6962E 01
6000.	0.7834E 02	40000.	0.2766E 01	200000.	0.4817E 01
8000.	0.4262E 02	50000.	0.1568E 01	300000.	0.1552E 01
10000.	0.2642E 02	60000.	0.9706E 00	400000.	0.6884E 00

(n) Temperature, 70 000° R (38 889 K)

PRESSURE	0.2533E 08 N/M2	TOTAL NUMBER DENSITY	0.4885E 26 1/M3
TEMPERATURE	70000. R	H IONIZATION POTENTIAL	103863. 1/CM
TEMPERATURE	38889. K	PLANCK MEAN OPACITY	0.2672E 01 1/CM
DENSITY	0.4288E-04 G/CM3	ROSSELAND MEAN OPACITY	0.6165E 00 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	1.360E 24	H2(EXCITED STATES)	1.539E 19
H(EXCITED STATES)	1.038E 24	H-	5.371E 20
H+	2.322E 25	H2+	5.132E 20
E	2.322E 25	H3+	5.773E 15
H2(GROUND STATE)	5.725E 18		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.1279E 05	11000.	0.1361E 02	70000.	0.3810E 00
1500.	0.2048E 04	12000.	0.1128E 02	75000.	0.3161E 00
2000.	0.5085E 03	13500.	0.8722E 01	80000.	0.2650E 00
2500.	0.2776E 03	15000.	0.6914E 01	90000.	0.1914E 00
3000.	0.1793E 03	20000.	0.3619E 01	100000.	0.1425E 00
4000.	0.9407E 02	25000.	0.4860E 01	125000.	0.5960E 01
5000.	0.5793E 02	27500.	0.3914E 01	150000.	0.3659E 01
5500.	0.4718E 02	30000.	0.3201E 01	175000.	0.2404E 01
6000.	0.3913E 02	40000.	0.1610E 01	200000.	0.1664E 01
8000.	0.2683E 02	50000.	0.9212E 00	300000.	0.5360E 00
10000.	0.1670E 02	60000.	0.5744E 00	400000.	0.2378E 00

[a]Wave numbers in table are photon wave numbers.

TABLE III. - Concluded. ABSORPTION COEFFICIENTS AND OPACITY OF HYDROGEN AT 250 ATMOSPHERES (2.533×10^7 N/m^2) PRESSURE[a]

(o) Temperature, 80 000° R (44 444 K)

PRESSURE	0.2533E 08 N/M2	TOTAL NUMBER DENSITY	0.4242E 26 1/M3
TEMPERATURE	80000. R	H IONIZATION POTENTIAL	104562. 1/CM
TEMPERATURE	44444. K	PLANCK MEAN OPACITY	0.1205E 01 1/CM
DENSITY	0.3660E-04 G/CM3	ROSSELAND MEAN OPACITY	0.3708E 00 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	5.512E 23	H2(EXCITED STATES)	3.786E 18
H(EXCITED STATES)	7.742E 23	H-	1.532E 20
H+	2.055E 25	H2+	1.474E 20
E	2.055E 25	H3+	5.186E 14
H2(GROUND STATE)	7.379E 17		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.1129E 05	11000.	0.8678E 01	70000.	0.2351E 00
1500.	0.8918E 03	12000.	0.7201E 01	75000.	0.1956E 00
2000.	0.3101E 03	13500.	0.5583E 01	80000.	0.1643E 00
2500.	0.1746E 03	15000.	0.4437E 01	90000.	0.1191E 00
3000.	0.1142E 03	20000.	0.2340E 01	100000.	0.8898E-01
4000.	0.6052E 02	25000.	0.2878E 01	125000.	0.2414E 01
5000.	0.3747E 02	27500.	0.2325E 01	150000.	0.1487E 01
5500.	0.3058E 02	30000.	0.1907E 01	175000.	0.9789E 00
6000.	0.2540E 02	40000.	0.9696E 00	200000.	0.6781E 00
8000.	0.1702E 02	50000.	0.5602E 00	300000.	0.2186E 00
10000.	0.1063E 02	60000.	0.3521E 00	400000.	0.9694E-01

(p) Temperature, 90 000° R (50 000 K)

PRESSURE	0.2533E 08 N/M2	TOTAL NUMBER DENSITY	0.3750E 26 1/M3
TEMPERATURE	90000. R	H IONIZATION POTENTIAL	105122. 1/CM
TEMPERATURE	50000. K	PLANCK MEAN OPACITY	0.5842E 00 1/CM
DENSITY	0.3208E-04 G/CM3	ROSSELAND MEAN OPACITY	0.2064E 00 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	2.565E 23	H2(EXCITED STATES)	1.087E 18
H(EXCITED STATES)	5.823E 23	H-	5.211E 19
H+	1.833E 25	H2+	5.048E 19
E	1.833E 25	H3+	6.618E 13
H2(GROUND STATE)	1.298E 17		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.9874E 04	11000.	0.5739E 01	70000.	0.1523E 00
1500.	0.4944E 03	12000.	0.4769E 01	75000.	0.1271E 00
2000.	0.1884E 03	13500.	0.3705E 01	80000.	0.1070E 00
2500.	0.1145E 03	15000.	0.2950E 01	90000.	0.7794E-01
3000.	0.7549E 02	20000.	0.1566E 01	100000.	0.5841E-01
4000.	0.4032E 02	25000.	0.1798E 01	125000.	0.1121E 01
5000.	0.2506E 02	27500.	0.1455E 01	150000.	0.6939E 00
5500.	0.2048E 02	30000.	0.1197E 01	175000.	0.4577E 00
6000.	0.1704E 02	40000.	0.6144E 00	200000.	0.3175E 00
8000.	0.1121E 02	50000.	0.3580E 00	300000.	0.1024E 00
10000.	0.7021E 01	60000.	0.2267E 00	400000.	0.4543E-01

[a]Wave numbers in table are photon wave numbers.

TABLE IV. - ABSORPTION COEFFICIENTS AND OPACITY OF HYDROGEN

AT 300 ATMOSPHERES (3.040×10^7 N/m^2) PRESSURE[a]

(a) Temperature, 3000° R (1667 K)

PRESSURE	0.3040E 08 N/M2	TOTAL NUMBER DENSITY	0.1321E 28 1/M3
TEMPERATURE	3000. R	H IONIZATION POTENTIAL	109679. 1/CM
TEMPERATURE	1667. K	PLANCK MEAN OPACITY	0.2952E-02 1/CM
DENSITY	0.4422E-02 G/CM3	ROSSELAND MEAN OPACITY	0.1602E-10 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	8.139E 21	H2(EXCITED STATES)	0.
H(EXCITED STATES)	4.703E-09	H-	2.283E 06
H+	0.	H2+	0.
E	8.588E 08	H3+	8.611E 08
H2(GROUND STATE)	1.321E 27		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.3662E-02	11000.	0.4937E-06	70000.	0.3513E-16
1500.	0.5297E-02	12000.	0.9617E-07	75000.	0.3117E-16
2000.	0.3330E-02	13500.	0.8163E-08	80000.	0.2789E-16
2500.	0.1188E-02	15000.	0.6843E-09	90000.	0.2289E-16
3000.	0.1051E-02	20000.	0.1658E-12	100000.	0.1913E-16
4000.	0.6188E-02	25000.	0.2208E-15	125000.	0.7235E 04
5000.	0.5011E-02	27500.	0.1588E-15	150000.	0.1110E 05
5500.	0.3246E-02	30000.	0.1384E-15	175000.	0.7598E 04
6000.	0.1484E-02	40000.	0.1470E-15	200000.	0.5814E 04
8000.	0.6308E-04	50000.	0.6938E-13	300000.	0.1769E 04
10000.	0.2514E-05	60000.	0.1262E-10	400000.	0.6773E 03

(b) Temperature, 5000° R (2778 K)

PRESSURE	0.3040E 08 N/M2	TOTAL NUMBER DENSITY	0.7927E 27 1/M3
TEMPERATURE	5000. R	H IONIZATION POTENTIAL	109679. 1/CM
TEMPERATURE	2778. K	PLANCK MEAN OPACITY	0.7691E-03 1/CM
DENSITY	0.2647E-02 G/CM3	ROSSELAND MEAN OPACITY	0.1269E-06 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	3.440E 24	H2(EXCITED STATES)	3.226E 07
H(EXCITED STATES)	4.313E 06	H-	3.358E 14
H+	4.696E 10	H2+	6.006E 10
E	5.505E 15	H3+	5.841E 15
H2(GROUND STATE)	7.892E 26		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.9596E-03	11000.	0.2447E-05	70000.	0.1999E-08
1500.	0.1695E-02	12000.	0.7476E-06	75000.	0.1745E-08
2000.	0.1797E-02	13500.	0.1357E-06	80000.	0.1537E-08
2500.	0.1133E-02	15000.	0.3501E-07	90000.	0.1236E-08
3000.	0.9386E-03	20000.	0.1220E-07	100000.	0.1006E-08
4000.	0.2239E-02	25000.	0.9473E-08	125000.	0.4337E 04
5000.	0.1982E-02	27500.	0.8467E-08	150000.	0.6640E 04
5500.	0.1420E-02	30000.	0.7626E-08	175000.	0.4545E 04
6000.	0.8390E-03	40000.	0.1159E-07	200000.	0.3477E 04
8000.	0.8469E-04	50000.	0.4631E-06	300000.	0.1058E 04
10000.	0.8039E-05	60000.	0.1235E-04	400000.	0.4052E 03

[a]Wave numbers in table are photon wave numbers.

TABLE IV. - Continued. ABSORPTION COEFFICIENTS AND OPACITY OF HYDROGEN AT 300 ATMSOPHERES (3.040×10^7 N/m^2) PRESSURE[a]

(c) Temperature, 7000° R (3889 K)

PRESSURE	0.3040E 08 N/M2	TOTAL NUMBER DENSITY	0.5662E 27 1/M3
TEMPERATURE	7000. R	H IONIZATION POTENTIAL	109670. 1/CM
TEMPERATURE	3889. K	PLANCK MEAN OPACITY	0.7054E-04 1/CM
DENSITY	0.1826E-02 G/CM3	ROSSELAND MEAN OPACITY	0.2902E-04 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	4.095E 25	H2(EXCITED STATES)	2.027E 13
H(EXCITED STATES)	1.002E 13	H-	7.656E 17
H+	1.306E 16	H2+	9.545E 15
E	4.384E 18	H3+	5.127E 18
H2(GROUND STATE)	5.252E 26		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.6894E-03	11000.	0.3618E-04	70000.	0.4394E-05
1500.	0.7463E-03	12000.	0.3662E-04	75000.	0.3832E-05
2000.	0.8070E-03	13500.	0.3573E-04	80000.	0.3372E-05
2500.	0.6263E-03	15000.	0.3382E-04	90000.	0.2708E-05
3000.	0.4702E-03	20000.	0.2629E-04	100000.	0.2201E-05
4000.	0.1227E-03	25000.	0.2069E-04	125000.	0.3055E 04
5000.	0.3773E-04	27500.	0.1862E-04	150000.	0.4522E 04
5500.	0.2312E-04	30000.	0.1699E-04	175000.	0.3092E 04
6000.	0.1535E-04	40000.	0.2575E-04	200000.	0.2361E 04
8000.	0.2538E-04	50000.	0.3403E-03	300000.	0.7193E 03
10000.	0.3445E-04	60000.	0.3699E-02	400000.	0.2764E 03

(d) Temperature, 10 000° R (5556 K)

PRESSURE	0.3040E 08 N/M2	TOTAL NUMBER DENSITY	0.3963E 27 1/M3
TEMPERATURE	10000. R	H IONIZATION POTENTIAL	109594. 1/CM
TEMPERATURE	5556. K	PLANCK MEAN OPACITY	0.5127E-02 1/CM
DENSITY	0.1015E-02 G/CM3	ROSSELAND MEAN OPACITY	0.4403E-02 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	1.864E 26	H2(EXCITED STATES)	2.851E 17
H(EXCITED STATES)	4.395E 17	H-	1.352E 20
H+	1.516E 20	H2+	5.847E 19
E	5.791E 20	H3+	5.041E 20
H2(GROUND STATE)	2.099E 26		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.6347E-01	11000.	0.6202E-02	70000.	0.8953E-03
1500.	0.2819E-01	12000.	0.6325E-02	75000.	0.8022E-03
2000.	0.1584E-01	13500.	0.6231E-02	80000.	0.7264E-03
2500.	0.1013E-01	15000.	0.5942E-02	90000.	0.6191E-03
3000.	0.7034E-02	20000.	0.4700E-02	100000.	0.5379E-03
4000.	0.3955E-02	25000.	0.3765E-02	125000.	0.1964E 04
5000.	0.2533E-02	27500.	0.3392E-02	150000.	0.2261E 04
5500.	0.2096E-02	30000.	0.3158E-02	175000.	0.1533E 04
6000.	0.1764E-02	40000.	0.4408E-02	200000.	0.1149E 04
8000.	0.4202E-02	50000.	0.2468E-01	300000.	0.3538E 03
10000.	0.5854E-02	60000.	0.1295E 00	400000.	0.1399E 03

[a]Wave numbers in table are photon wave numbers.

TABLE IV. - Continued. ABSORPTION COEFFICIENTS AND OPACITY OF HYDROGEN AT 300 ATMOSPHERES (3.040×10^7 N/m^2) PRESSURE[a]

(e) Temperature, 13 000° R (7222 K)

PRESSURE	0.3040E 08 N/M2	TOTAL NUMBER DENSITY	0.3049E 27 1/M3
TEMPERATURE	13000. R	H IONIZATION POTENTIAL	109349. 1/CM
TEMPERATURE	7222. K	PLANCK MEAN OPACITY	0.7157E-01 1/CM
DENSITY	0.5940E-03 G/CM3	ROSSELAND MEAN OPACITY	0.5709E-01 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	2.548E 26	H2(EXCITED STATES)	2.066E 19
H(EXCITED STATES)	8.975E 19	H-	1.798E 21
H+	1.078E 22	H2+	1.887E 21
E	1.211E 22	H3+	1.242E 21
H2(GROUND STATE)	5.008E 25		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.1339E 01	11000.	0.8516E-01	70000.	0.1430E-01
1500.	0.5964E 00	12000.	0.8681E-01	75000.	0.1307E-01
2000.	0.3365E 00	13500.	0.8559E-01	80000.	0.1208E-01
2500.	0.2162E 00	15000.	0.8197E-01	90000.	0.1067E-01
3000.	0.1509E 00	20000.	0.6603E-01	100000.	0.9610E-02
4000.	0.8612E-01	25000.	0.5372E-01	125000.	0.1388E 04
5000.	0.5616E-01	27500.	0.4782E-01	150000.	0.1101E 04
5500.	0.4695E-01	30000.	0.4408E-01	175000.	0.7337E 03
6000.	0.3996E-01	40000.	0.4255E-01	200000.	0.5287E 03
8000.	0.6271E-01	50000.	0.1028E 00	300000.	0.1664E 03
10000.	0.8109E-01	60000.	0.3171E 00	400000.	0.6974E 02

(f) Temperature, 16 000° R (8889 K)

PRESSURE	0.3040E 08 N/M2	TOTAL NUMBER DENSITY	0.2477E 27 1/M3
TEMPERATURE	16000. R	H IONIZATION POTENTIAL	108835. 1/CM
TEMPERATURE	8889. K	PLANCK MEAN OPACITY	0.3624E 00 1/CM
DENSITY	0.4350E-03 G/CM3	ROSSELAND MEAN OPACITY	0.2275E 00 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	2.351E 26	H2(EXCITED STATES)	1.873E 20
H(EXCITED STATES)	2.031E 21	H-	3.244E 21
H+	1.025E 23	H2+	3.364E 21
E	1.036E 23	H3+	9.844E 20
H2(GROUND STATE)	1.234E 25		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.1006E 02	11000.	0.4099E 00	70000.	0.6684E-01
1500.	0.4476E 01	12000.	0.4182E 00	75000.	0.6066E-01
2000.	0.2524E 01	13500.	0.4084E 00	80000.	0.5564E-01
2500.	0.1621E 01	15000.	0.3897E 00	90000.	0.4846E-01
3000.	0.1131E 01	20000.	0.3142E 00	100000.	0.4303E-01
4000.	0.6445E 00	25000.	0.2553E 00	125000.	0.1095E 04
5000.	0.4199E 00	27500.	0.2395E 00	150000.	0.7311E 03
5500.	0.3507E 00	30000.	0.2165E 00	175000.	0.4824E 03
6000.	0.2983E 00	40000.	0.1659E 00	200000.	0.3388E 03
8000.	0.3419E 00	50000.	0.2054E 00	300000.	0.1082E 03
10000.	0.3979E 00	60000.	0.3680E 00	400000.	0.4700E 02

[a]Wave numbers in table are photon wave numbers.

TABLE IV. - Continued. ABSORPTION COEFFICIENTS AND OPACITY OF HYDROGEN AT 300 ATMOSPHERES (3.040×10^7 N/m^2) PRESSURE[a]

(g) Temperature, 20 000° R (11 111 K)

PRESSURE	0.3040E 08 N/M2	TOTAL NUMBER DENSITY	0.1982E 27 1/M3
TEMPERATURE	20000. R	H IONIZATION POTENTIAL	107768. 1/CM
TEMPERATURE	11111. K	PLANCK MEAN OPACITY	0.1668E 01 1/CM
DENSITY	0.3356E-03 G/CM3	ROSSELAND MEAN OPACITY	0.5452E 00 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	1.938E 26	H2(EXCITED STATES)	1.055E 21
H(EXCITED STATES)	2.913E 22	H-	2.646E 22
H+	6.905E 23	H2+	2.521E 22
E	6.899E 23	H3+	7.108E 20
H2(GROUND STATE)	2.961E 24		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.5992E 02	11000.	0.1604E 01	70000.	0.2299E 00
1500.	0.2650E 02	12000.	0.1555E 01	75000.	0.2066E 00
2000.	0.1488E 02	13500.	0.1470E 01	80000.	0.1876E 00
2500.	0.9516E 01	15000.	0.1376E 01	90000.	0.1603E 00
3000.	0.6613E 01	20000.	0.1081E 01	100000.	0.1399E 00
4000.	0.3737E 01	25000.	0.8659E 00	125000.	0.8632E 03
5000.	0.2579E 01	27500.	0.9712E 00	150000.	0.5420E 03
5500.	0.2142E 01	30000.	0.8517E 00	175000.	0.3561E 03
6000.	0.1810E 01	40000.	0.5458E 00	200000.	0.2475E 03
8000.	0.1510E 01	50000.	0.3890E 00	300000.	0.7951E 02
10000.	0.1498E 01	60000.	0.2935E 00	400000.	0.3504E 02

(h) Temperature, 23 000° R (12 778 K)

PRESSURE	0.3040E 08 N/M2	TOTAL NUMBER DENSITY	0.1725E 27 1/M3
TEMPERATURE	23000. R	H IONIZATION POTENTIAL	106765. 1/CM
TEMPERATURE	12778. K	PLANCK MEAN OPACITY	0.4153E 01 1/CM
DENSITY	0.2878E-03 G/CM3	ROSSELAND MEAN OPACITY	0.8996E 00 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	1.673E 26	H2(EXCITED STATES)	2.444E 21
H(EXCITED STATES)	1.172E 23	H-	4.522E 22
H+	1.873E 24	H2+	4.215E 22
E	1.871E 24	H3+	5.942E 20
H2(GROUND STATE)	1.294E 24		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.1693E 03	11000.	0.3299E 01	70000.	0.4336E 00
1500.	0.7390E 02	12000.	0.3071E 01	75000.	0.3863E 00
2000.	0.4109E 02	13500.	0.2776E 01	80000.	0.3481E 00
2500.	0.2607E 02	15000.	0.2516E 01	90000.	0.2931E 00
3000.	0.1797E 02	20000.	0.1850E 01	100000.	0.2527E 00
4000.	0.1116E 02	25000.	0.2455E 01	125000.	0.7382E 03
5000.	0.7063E 01	27500.	0.2147E 01	150000.	0.4573E 03
5500.	0.5803E 01	30000.	0.1847E 01	175000.	0.3001E 03
6000.	0.4849E 01	40000.	0.1119E 01	200000.	0.2081E 03
8000.	0.3395E 01	50000.	0.7677E 00	300000.	0.6694E 02
10000.	0.3571E 01	60000.	0.5642E 00	400000.	0.2960E 02

[a]Wave numbers in table are photon wave numbers.

TABLE IV. - Continued. ABSORPTION COEFFICIENTS AND OPACITY OF HYDROGEN AT 300 ATMOSPHERES (3.040×10^7 N/m^2) PRESSURE[a]

(i) Temperature, 26 000° R (14 444 K)

PRESSURE	0.3040E 08 N/M2	TOTAL NUMBER DENSITY	0.1530E 27 1/M3
TEMPERATURE	26000. R	H IONIZATION POTENTIAL	105678. 1/CM
TEMPERATURE	14444. K	PLANCK MEAN OPACITY	0.8495E 01 1/CM
DENSITY	0.2504E-03 G/CM3	ROSSELAND MEAN OPACITY	0.1296E 01 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	1.438E 26	H2(EXCITED STATES)	4.395E 21
H(EXCITED STATES)	3.398E 23	H-	6.407E 22
H+	4.022E 24	H2+	5.914E 22
E	4.017E 24	H3+	4.976E 20
H2(GROUND STATE)	6.350E 23		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.4916E 03	11000.	0.6510E 01	70000.	0.7028E 00
1500.	0.1811E 03	12000.	0.5836E 01	75000.	0.6206E 00
2000.	0.9905E 02	13500.	0.5043E 01	80000.	0.5546E 00
2500.	0.6229E 02	15000.	0.4420E 01	90000.	0.4596E 00
3000.	0.4884E 02	20000.	0.3041E 01	100000.	0.3910E 00
4000.	0.2698E 02	25000.	0.4780E 01	125000.	0.6321E 03
5000.	0.1696E 02	27500.	0.4081E 01	150000.	0.3892E 03
5500.	0.1389E 02	30000.	0.3451E 01	175000.	0.2553E 03
6000.	0.1157E 02	40000.	0.1983E 01	200000.	0.1769E 03
8000.	0.7245E 01	50000.	0.1308E 01	300000.	0.5692E 02
10000.	0.7369E 01	60000.	0.9340E 00	400000.	0.2521E 02

(j) Temperature, 30 000° R (16 667 K)

PRESSURE	0.3040E 08 N/M2	TOTAL NUMBER DENSITY	0.1335E 27 1/M3
TEMPERATURE	30000. R	H IONIZATION POTENTIAL	104253. 1/CM
TEMPERATURE	16667. K	PLANCK MEAN OPACITY	0.1679E 02 1/CM
DENSITY	0.2096E-03 G/CM3	ROSSELAND MEAN OPACITY	0.1547E 01 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	1.150E 26	H2(EXCITED STATES)	5.478E 21
H(EXCITED STATES)	8.905E 23	H-	8.126E 22
H+	8.586E 24	H2+	7.472E 22
E	8.580E 24	H3+	3.630E 20
H2(GROUND STATE)	2.653E 23		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.1977E 04	11000.	0.1389E 02	70000.	0.9574E 00
1500.	0.6034E 03	12000.	0.1199E 02	75000.	0.8147E 00
2000.	0.2995E 03	13500.	0.9861E 01	80000.	0.7011E 00
2500.	0.1861E 03	15000.	0.8292E 01	90000.	0.5381E 00
3000.	0.1267E 03	20000.	0.5181E 01	100000.	0.4233E 00
4000.	0.6916E 02	25000.	0.9416E 01	125000.	0.5040E 03
5000.	0.4314E 02	27500.	0.7668E 01	150000.	0.3091E 03
5500.	0.3523E 02	30000.	0.6349E 01	175000.	0.2027E 03
6000.	0.2925E 02	40000.	0.3370E 01	200000.	0.1403E 03
8000.	0.2455E 02	50000.	0.2059E 01	300000.	0.4519E 02
10000.	0.1638E 02	60000.	0.1368E 01	400000.	0.2003E 02

[a]Wave numbers in table are photon wave numbers.

TABLE IV. - Continued. ABSORPTION COEFFICIENTS AND OPACITY OF HYDROGEN AT 300 ATMOSPHERES (3.040×10^7 N/m^2) PRESSURE[a]

(k) Temperature, 40 000° R (22 222 K)

PRESSURE	C.3040E 08 N/M2	TOTAL NUMBER DENSITY	0.1032E 27 1/M3
TEMPERATURE	40000. R	H IONIZATION POTENTIAL	101845. 1/CM
TEMPERATURE	22222. K	PLANCK MEAN OPACITY	0.3008E 02 1/CM
DENSITY	0.1326E-03 G/CM3	ROSSELAND MEAN OPACITY	0.2186E 01 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	5.274E 25	H2(EXCITED STATES)	3.947E 21
H(EXCITED STATES)	2.230E 24	H-	5.926E 22
H+	2.402E 25	H2+	5.487E 22
E	2.402E 25	H3+	7.499E 19
H2(GROUND STATE)	2.696E 22		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.1355E 05	11000.	0.3866E 02	70000.	0.1653E 01
1500.	0.4847E 04	12000.	0.3215E 02	75000.	0.1381E 01
2000.	0.1365E 04	13500.	0.2503E 02	80000.	0.1168E 01
2500.	0.7308E 03	15000.	0.2000E 02	90000.	0.8638E 00
3000.	0.4601E 03	20000.	0.3463E 02	100000.	0.6586E 00
4000.	0.2390E 03	25000.	0.2089E 02	125000.	0.2308E 03
5000.	0.2047E 03	27500.	0.1674E 02	150000.	0.1411E 03
5500.	0.1674E 03	30000.	0.1364E 02	175000.	0.9254E 02
6000.	0.1392E 03	40000.	0.6798E 01	200000.	0.6401E 02
8000.	0.7582E 02	50000.	0.3905E 01	300000.	0.2062E 02
10000.	0.4730E 02	60000.	0.2461E 01	400000.	0.9149E 01

(l) Temperature, 50 000° R (27 778 K)

PRESSURE	0.3040E 08 N/M2	TOTAL NUMBER DENSITY	0.8371E 26 1/M3
TEMPERATURE	50000. R	H IONIZATION POTENTIAL	101616. 1/CM
TEMPERATURE	27778. K	PLANCK MEAN OPACITY	0.1978E 02 1/CM
DENSITY	0.8678E-04 G/CM3	ROSSELAND MEAN OPACITY	0.1887E 01 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	1.756E 25	H2(EXCITED STATES)	3.890E 20
H(EXCITED STATES)	2.378E 24	H-	1.728E 22
H+	3.187E 25	H2+	1.619E 22
E	3.187E 25	H3+	4.765E 18
H2(GROUND STATE)	1.838E 21		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.1696E 05	11000.	0.4245E 02	70000.	0.1410E 01
1500.	0.9995E 04	12000.	0.3507E 02	75000.	0.1169E 01
2000.	0.1990E 04	13500.	0.2702E 02	80000.	0.9796E 00
2500.	0.9316E 03	15000.	0.2135E 02	90000.	0.7099E 00
3000.	0.5730E 03	20000.	0.3156E 02	100000.	0.5313E 00
4000.	0.2871E 03	25000.	0.1902E 02	125000.	0.7688E 02
5000.	0.2307E 03	27500.	0.1522E 02	150000.	0.4700E 02
5500.	0.1883E 03	30000.	0.1237E 02	175000.	0.3082E 02
6000.	0.1564E 03	40000.	0.6103E 01	200000.	0.2132E 02
8000.	0.8460E 02	50000.	0.3449E 01	300000.	0.6868E 01
10000.	0.5225E 02	60000.	0.2134E 01	400000.	0.3048E 01

[a]Wave numbers in table are photon wave numbers.

TABLE IV. - Continued. ABSORPTION COEFFICIENTS AND OPACITY OF HYDROGEN AT 300 ATMOSPHERES (3.040×10^7 N/m^2) PRESSURE[a]

(m) Temperature, 60 000° R (33 333 K)

PRESSURE	0.3040E 08 N/M2	TOTAL NUMBER DENSITY	0.6930E 26 1/M3
TEMPERATURE	60000. R	H IONIZATION POTENTIAL	102418. 1/CM
TEMPERATURE	33333. K	PLANCK MEAN OPACITY	0.8765E 01 1/CM
DENSITY	0.6405E-04 G/CM3	ROSSELAND MEAN OPACITY	0.1322E 01 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	5.451E 24	H2(EXCITED STATES)	1.440E 20
H(EXCITED STATES)	1.792E 24	H-	3.765E 21
H+	3.102E 25	H2+	3.565E 21
E	3.102E 25	H3+	2.198E 17
H2(GROUND STATE)	1.231E 20		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.1654E 05	11000.	0.2983E 02	70000.	0.8879E 00
1500.	0.9209E 04	12000.	0.2466E 02	75000.	0.7353E 00
2000.	0.1384E 04	13500.	0.1902E 02	80000.	0.6156E 00
2500.	0.6602E 03	15000.	0.1503E 02	90000.	0.4440E 00
3000.	0.4092E 03	20000.	0.7808E 01	100000.	0.3305E 00
4000.	0.2072E 03	25000.	0.1176E 02	125000.	0.2388E 02
5000.	0.1608E 03	27500.	0.9440E 01	150000.	0.1462E 02
5500.	0.1313E 03	30000.	0.7697E 01	175000.	0.9596E 01
6000.	0.1092E 03	40000.	0.3827E 01	200000.	0.6639E 01
8000.	0.5926E 02	50000.	0.2171E 01	300000.	0.2139E 01
10000.	0.3668E 02	60000.	0.1345E 01	400000.	0.9489E 00

(n) Temperature, 70 000° R (38 889 K)

PRESSURE	0.3040E 08 N/M2	TOTAL NUMBER DENSITY	0.5880E 26 1/M3
TEMPERATURE	70000. R	H IONIZATION POTENTIAL	103316. 1/CM
TEMPERATURE	38889. K	PLANCK MEAN OPACITY	0.3758E 01 1/CM
DENSITY	0.5189E-04 G/CM3	ROSSELAND MEAN OPACITY	0.8654E 00 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	1.908E 24	H2(EXCITED STATES)	2.742E 19
H(EXCITED STATES)	1.306E 24	H-	9.019E 20
H+	2.779E 25	H2+	8.618E 20
E	2.779E 25	H3+	1.360E 16
H2(GROUND STATE)	1.127E 19		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.1511E 05	11000.	0.1906E 02	70000.	0.5346E 00
1500.	0.6426E 04	12000.	0.1579E 02	75000.	0.4435E 00
2000.	0.8051E 03	13500.	0.1220E 02	80000.	0.3719E 00
2500.	0.4105E 03	15000.	0.9673E 01	90000.	0.2687E 00
3000.	0.2596E 03	20000.	0.5062E 01	100000.	0.2001E 00
4000.	0.1338E 03	25000.	0.6810E 01	125000.	0.8363E 01
5000.	0.8182E 02	27500.	0.5484E 01	150000.	0.5134E 01
5500.	0.6650E 02	30000.	0.4486E 01	175000.	0.3373E 01
6000.	0.6903E 02	40000.	0.2256E 01	200000.	0.2335E 01
8000.	0.3764E 02	50000.	0.1292E 01	300000.	0.7522E 00
10000.	0.2340E 02	60000.	0.8057E 00	400000.	0.3337E 00

[a]Wave numbers in table are photon wave numbers.

TABLE IV. - Concluded. ABSORPTION COEFFICIENTS AND OPACITY OF HYDROGEN AT 300 ATMOSPHERES (3.040×10^7 N/m^2) PRESSURE[a]

(o) Temperature, 80 000° R (44 444 K)

PRESSURE	0.3040E 08 N/M2	TOTAL NUMBER DENSITY	0.5103E 26 1/M3
TEMPERATURE	80000. R	H IONIZATION POTENTIAL	104075. 1/CM
TEMPERATURE	44444. K	PLANCK MEAN OPACITY	0.1708E 01 1/CM
DENSITY	0.4416E-04 G/CM3	ROSSELAND MEAN OPACITY	0.5259E 00 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	7.804E 23	H2(EXCITED STATES)	5.670E 18
H(EXCITED STATES)	9.688E 23	H-	2.601E 20
H+	2.464E 25	H2+	2.503E 20
E	2.464E 25	H3+	1.247E 15
H2(GROUND STATE)	1.479E 18		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.1353E 05	11000.	0.1235E 02	70000.	0.3336E 00
1500.	0.2721E 04	12000.	0.1025E 02	75000.	0.2776E 00
2000.	0.4837E 03	13500.	0.7944E 01	80000.	0.2333E 00
2500.	0.2595E 03	15000.	0.6312E 01	90000.	0.1691E 00
3000.	0.1669E 03	20000.	0.3328E 01	100000.	0.1263E 00
4000.	0.8729E 02	25000.	0.4084E 01	125000.	0.3418E 01
5000.	0.5377E 02	27500.	0.3298E 01	150000.	0.2106E 01
5500.	0.4381E 02	30000.	0.2705E 01	175000.	0.1385E 01
6000.	0.3636E 02	40000.	0.1376E 01	200000.	0.9600E 00
8000.	0.2426E 02	50000.	0.7949E 00	300000.	0.3094E 00
10000.	0.1514E 02	60000.	0.4997E 00	400000.	0.1373E 00

(p) Temperature, 90 000° R (50 000 K)

PRESSURE	0.3040E 08 N/M2	TOTAL NUMBER DENSITY	0.4509E 26 1/M3
TEMPERATURE	90000. R	H IONIZATION POTENTIAL	104688. 1/CM
TEMPERATURE	50000. K	PLANCK MEAN OPACITY	0.8364E 00 1/CM
DENSITY	0.3866E-04 G/CM3	ROSSELAND MEAN OPACITY	0.2935E 00 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	3.645E 23	H2(EXCITED STATES)	1.976E 18
H(EXCITED STATES)	7.501E 23	H-	8.882E 19
H+	2.199E 25	H2+	8.604E 19
E	2.199E 25	H3+	1.603E 14
H2(GROUND STATE)	2.620E 17		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.1213E 05	11000.	0.8190E 01	70000.	0.2168E 00
1500.	0.1027E 04	12000.	0.6804E 01	75000.	0.1809E 00
2000.	0.3054E 03	13500.	0.5285E 01	80000.	0.1524E 00
2500.	0.1693E 03	15000.	0.4207E 01	90000.	0.1110E 00
3000.	0.1102E 03	20000.	0.2233E 01	100000.	0.8317E-01
4000.	0.5819E 02	25000.	0.2559E 01	125000.	0.1594E 01
5000.	0.3601E 02	27500.	0.2072E 01	150000.	0.9860E 00
5500.	0.2939E 02	30000.	0.1704E 01	175000.	0.6505E 00
6000.	0.2443E 02	40000.	0.8745E 00	200000.	0.4511E 00
8000.	0.1602E 02	50000.	0.5096E 00	300000.	0.1456E 00
10000.	0.1002E 02	60000.	0.3227E 00	400000.	0.6456E-01

[a]Wave numbers in table are photon wave numbers.

TABLE V. - ABSORPTION COEFFICIENTS AND OPACITY OF HYDROGEN

AT 500 ATMOSPHERES (5.066×10^7 N/m^2) PRESSURE[a]

(a) Temperature, 3000° R (1667 K)

PRESSURE	0.5066E 08 N/M2	TOTAL NUMBER DENSITY	0.2202E 28 1/M3
TEMPERATURE	3000. R	H IONIZATION POTENTIAL	109679. 1/CM
TEMPERATURE	1667. K	PLANCK MEAN OPACITY	0.8199E-02 1/CM
DENSITY	0.7370E-02 G/CM3	ROSSELAND MEAN OPACITY	0.3894E-10 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	1.051E 22	H2(EXCITED STATES)	0.
H(EXCITED STATES)	6.072E-09	H-	4.322E 06
H+	0.	H2+	0.
E	1.259E 09	H3+	1.264E 09
H2(GROUND STATE)	2.202E 27		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.1017E-01	11000.	0.1371E-05	70000.	0.7879E-16
1500.	0.1471E-01	12000.	0.2671E-06	75000.	0.7002E-16
2000.	0.9249E-02	13500.	0.2267E-07	80000.	0.6273E-16
2500.	0.3301E-02	15000.	0.1901E-08	90000.	0.5160E-16
3000.	0.2920E-02	20000.	0.4605E-12	100000.	0.4322E-16
4000.	0.1719E-01	25000.	0.5192E-15	125000.	0.1206E 05
5000.	0.1392E-01	27500.	0.3587E-15	150000.	0.1850E 05
5500.	0.9017E-02	30000.	0.3115E-15	175000.	0.1266E 05
6000.	0.4123E-02	40000.	0.2954E-15	200000.	0.9690E 04
8000.	0.1752E-03	50000.	0.1157E-12	300000.	0.2949E 04
10000.	0.6983E-05	60000.	0.2104E-10	400000.	0.1129E 04

(b) Temperature, 5000° R (2778 K)

PRESSURE	0.5066E 08 N/M2	TOTAL NUMBER DENSITY	0.1321E 28 1/M3
TEMPERATURE	5000. R	H IONIZATION POTENTIAL	109679. 1/CM
TEMPERATURE	2778. K	PLANCK MEAN OPACITY	0.2141E-02 1/CM
DENSITY	0.4414E-02 G/CM3	ROSSELAND MEAN OPACITY	0.2643E-06 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	4.443E 24	H2(EXCITED STATES)	5.381E 07
H(EXCITED STATES)	5.570E 06	H-	6.314E 14
H+	4.167E 10	H2+	5.883E 10
E	8.015E 15	H3+	8.646E 15
H2(GROUND STATE)	1.317E 27		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.2671E-02	11000.	0.6797E-05	70000.	0.3819E-08
1500.	0.4717E-02	12000.	0.2066E-05	75000.	0.3335E-08
2000.	0.5000E-02	13500.	0.3634E-06	80000.	0.2938E-08
2500.	0.3155E-02	15000.	0.8396E-07	90000.	0.2364E-08
3000.	0.2612E-02	20000.	0.2352E-07	100000.	0.1925E-08
4000.	0.6231E-02	25000.	0.1817E-07	125000.	0.7230E 04
5000.	0.5517E-02	27500.	0.1622E-07	150000.	0.1107E 05
5500.	0.3951E-02	30000.	0.1458E-07	175000.	0.7580E 04
6000.	0.2335E-02	40000.	0.2056E-07	200000.	0.5800E 04
8000.	0.2357E-03	50000.	0.7735E-06	300000.	0.1765E 04
10000.	0.2236E-04	60000.	0.2060E-04	400000.	0.6758E 03

[a]Wave numbers in table are photon wave numbers.

TABLE V. - Continued. ABSORPTION COEFFICIENTS AND OPACITY OF HYDROGEN AT 500 ATMOSPHERES (5.066×10^7 N/m^2) PRESSURE[a]

(c) Temperature, 7000° R (3889 K)

PRESSURE	0.5066E 08 N/M2	TOTAL NUMBER DENSITY	0.9437E 27 1/M3
TEMPERATURE	7000. R	H IONIZATION POTENTIAL	109668. 1/CM
TEMPERATURE	3889. K	PLANCK MEAN OPACITY	0.1773E-03 1/CM
DENSITY	0.3069E-02 G/CM3	ROSSELAND MEAN OPACITY	0.5820E-04 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	5.331E 25	H2(EXCITED STATES)	3.435E 13
H(EXCITED STATES)	1.303E 13	H-	1.448E 18
H+	1.171E 16	H2+	1.115E 16
E	6.370E 18	H3+	7.795E 18
H2(GROUND STATE)	8.903E 26		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.1780E-02	11000.	0.6970E-04	70000.	0.8349E-05
1500.	0.2056E-02	12000.	0.7032E-04	75000.	0.7283E-05
2000.	0.2269E-02	13500.	0.6840E-04	80000.	0.6408E-05
2500.	0.1768E-02	15000.	0.6463E-04	90000.	0.5148E-05
3000.	0.1329E-02	20000.	0.5009E-04	100000.	0.4184E-05
4000.	0.3406E-03	25000.	0.3935E-04	125000.	0.5109E 04
5000.	0.1008E-03	27500.	0.3539E-04	150000.	0.7623E 04
5500.	0.6022E-04	30000.	0.3223E-04	175000.	0.5214E 04
6000.	0.3892E-04	40000.	0.4594E-04	200000.	0.3983E 04
8000.	0.5079E-04	50000.	0.5785E-03	300000.	0.1213E 04
10000.	0.6673E-04	60000.	0.6272E-02	400000.	0.4657E 03

(d) Temperature, 10 000° R (5556 K)

PRESSURE	0.5066E 08 N/M2	TOTAL NUMBER DENSITY	0.6606E 27 1/M3
TEMPERATURE	10000. R	H IONIZATION POTENTIAL	109572. 1/CM
TEMPERATURE	5556. K	PLANCK MEAN OPACITY	0.1067E-01 1/CM
DENSITY	0.1779E-02 G/CM3	ROSSELAND MEAN OPACITY	0.9083E-02 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	2.581E 26	H2(EXCITED STATES)	5.448E 17
H(EXCITED STATES)	6.048E 17	H-	2.763E 20
H+	1.431E 20	H2+	7.637E 19
E	8.548E 20	H3+	9.117E 20
H2(GROUND STATE)	4.025E 26		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.1464E 00	11000.	0.1276E-01	70000.	0.1746E-02
1500.	0.6499E-01	12000.	0.1299E-01	75000.	0.1550E-02
2000.	0.3650E-01	13500.	0.1277E-01	80000.	0.1391E-02
2500.	0.2332E-01	15000.	0.1217E-01	90000.	0.1164E-02
3000.	0.1617E-01	20000.	0.9587E-02	100000.	0.9914E-03
4000.	0.9066E-02	25000.	0.7649E-02	125000.	0.3332E 04
5000.	0.5786E-02	27500.	0.6910E-02	150000.	0.4070E 04
5500.	0.4777E-02	30000.	0.6413E-02	175000.	0.2766E 04
6000.	0.4011E-02	40000.	0.8667E-02	200000.	0.2083E 04
8000.	0.8794E-02	50000.	0.4744E-01	300000.	0.6396E 03
10000.	0.1208E-01	60000.	0.2483E 00	400000.	0.2510E 03

[a]Wave numbers in table are photon wave numbers.

TABLE V. - Continued. ABSORPTION COEFFICIENTS AND OPACITY OF HYDROGEN AT 500 ATMOSPHERES (5.066×10^7 N/m^2) PRESSURE[a]

(e) Temperature, 13 000° R (7222 K)

PRESSURE	0.5066E 08 N/M2	TOTAL NUMBER DENSITY	0.5081E 27 1/M3
TEMPERATURE	13000. R	H IONIZATION POTENTIAL	109287. 1/CM
TEMPERATURE	7222. K	PLANCK MEAN OPACITY	0.1447E 00 1/CM
DENSITY	0.1047E-02 G/CM3	ROSSELAND MEAN OPACITY	0.1159E 00 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	3.905E 26	H2(EXCITED STATES)	4.786E 19
H(EXCITED STATES)	1.349E 20	H-	3.626E 21
H+	1.271E 22	H2+	3.409E 21
E	1.594E 22	H3+	3.439E 21
H2(GROUND STATE)	1.176E 26		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.2830E 01	11000.	0.1720E 00	70000.	0.2804E-01
1500.	0.1260E 01	12000.	0.1751E 00	75000.	0.2554E-01
2000.	0.7103E 00	13500.	0.1724E 00	80000.	0.2351E-01
2500.	0.4561E 00	15000.	0.1650E 00	90000.	0.2064E-01
3000.	0.3181E 00	20000.	0.1325E 00	100000.	0.1847E-01
4000.	0.1811E 00	25000.	0.1078E 00	125000.	0.2351E 04
5000.	0.1177E 00	27500.	0.9602E-01	150000.	0.2030E 04
5500.	0.9823E-01	30000.	0.8876E-01	175000.	0.1360E 04
6000.	0.8344E-01	40000.	0.8947E-01	200000.	0.9901E 03
8000.	0.1277E 00	50000.	0.2333E 00	300000.	0.3097E 03
10000.	0.1640E 00	60000.	0.7382E 00	400000.	0.1278E 03

(f) Temperature, 16 000° R (8889 K)

PRESSURE	0.5066E 08 N/M2	TOTAL NUMBER DENSITY	0.4129E 27 1/M3
TEMPERATURE	16000. R	H IONIZATION POTENTIAL	108696. 1/CM
TEMPERATURE	8889. K	PLANCK MEAN OPACITY	0.7371E 00 1/CM
DENSITY	0.7447E-03 G/CM3	ROSSELAND MEAN OPACITY	0.4821E 00 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	3.803E 26	H2(EXCITED STATES)	4.750E 20
H(EXCITED STATES)	3.158E 21	H-	1.727E 22
H+	1.309E 23	H2+	1.727E 22
E	1.342E 23	H3+	3.287E 21
H2(GROUND STATE)	3.227E 25		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.2135E 02	11000.	0.8590E 00	70000.	0.1389E 00
1500.	0.9498E 01	12000.	0.8737E 00	75000.	0.1260E 00
2000.	0.5356E 01	13500.	0.8537E 00	80000.	0.1156E 00
2500.	0.3440E 01	15000.	0.8148E 00	90000.	0.1007E 00
3000.	0.2400E 01	20000.	0.6574E 00	100000.	0.8939E-01
4000.	0.1367E 01	25000.	0.5347E 00	125000.	0.1839E 04
5000.	0.8905E 00	27500.	0.4929E 00	150000.	0.1286E 04
5500.	0.7437E 00	30000.	0.4476E 00	175000.	0.8509E 03
6000.	0.6365E 00	40000.	0.3548E 00	200000.	0.6022E 03
8000.	0.7173E 00	50000.	0.4790E 00	300000.	0.1914E 03
10000.	0.8340E 00	60000.	0.9175E 00	400000.	0.8232E 02

[a]Wave numbers in table are photon wave numbers.

TABLE V. - Continued. ABSORPTION COEFFICIENTS AND OPACITY OF HYDROGEN AT 500 ATMOSPHERES (5.066×10^7 N/m^2) PRESSURE[a]

(g) Temperature, 20 000° R (11 111 K)

PRESSURE	0.5066E 08 N/M2	TOTAL NUMBER DENSITY	0.3304E 27 1/M3
TEMPERATURE	20000. R	H IONIZATION POTENTIAL	107464. 1/CM
TEMPERATURE	11111. K	PLANCK MEAN OPACITY	0.3210E 01 1/CM
DENSITY	0.5650E-03 G/CM3	ROSSELAND MEAN OPACITY	0.1148E 01 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	3.203E 26	H2(EXCITED STATES)	2.711E 21
H(EXCITED STATES)	4.504E 22	H-	5.736E 22
H+	9.050E 23	H2+	5.461E 22
E	9.048E 23	H3+	2.545E 21
H2(GROUND STATE)	8.089E 24		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.1275E 03	11000.	0.3375E 01	70000.	0.4890E 00
1500.	0.5641E 02	12000.	0.3288E 01	75000.	0.4401E 00
2000.	0.3169E 02	13500.	0.3124E 01	80000.	0.4002E 00
2500.	0.2028E 02	15000.	0.2935E 01	90000.	0.3428E 00
3000.	0.1410E 02	20000.	0.2321E 01	100000.	0.2998E 00
4000.	0.7980E 01	25000.	0.1865E 01	125000.	0.1444E 04
5000.	0.5332E 01	27500.	0.1975E 01	150000.	0.9227E 03
5500.	0.4433E 01	30000.	0.1743E 01	175000.	0.6069E 03
6000.	0.3751E 01	40000.	0.1137E 01	200000.	0.4232E 03
8000.	0.3186E 01	50000.	0.8186E 00	300000.	0.1357E 03
10000.	0.3445E 01	60000.	0.6216E 00	400000.	0.5955E 02

(h) Temperature, 23 000° R (12 778 K)

PRESSURE	0.5066E 08 N/M2	TOTAL NUMBER DENSITY	0.2875E 27 1/M3
TEMPERATURE	23000. R	H IONIZATION POTENTIAL	106299. 1/CM
TEMPERATURE	12778. K	PLANCK MEAN OPACITY	0.7631E 01 1/CM
DENSITY	0.4832E-03 G/CM3	ROSSELAND MEAN OPACITY	0.1882E 01 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	2.786E 26	H2(EXCITED STATES)	6.210E 21
H(EXCITED STATES)	1.787E 23	H-	9.974E 22
H+	2.482E 24	H2+	9.302E 22
E	2.478E 24	H3+	2.184E 21
H2(GROUND STATE)	3.590E 24		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.3561E 03	11000.	0.6776E 01	70000.	0.9215E 00
1500.	0.1544E 03	12000.	0.6368E 01	75000.	0.8236E 00
2000.	0.8587E 02	13500.	0.5818E 01	80000.	0.7441E 00
2500.	0.5452E 02	15000.	0.5317E 01	90000.	0.6297E 00
3000.	0.3762E 02	20000.	0.3971E 01	100000.	0.5450E 00
4000.	0.2235E 02	25000.	0.4798E 01	125000.	0.1237E 04
5000.	0.1417E 02	27500.	0.4255E 01	150000.	0.7736E 03
5500.	0.1166E 02	30000.	0.3693E 01	175000.	0.5081E 03
6000.	0.9753E 01	40000.	0.2296E 01	200000.	0.3529E 03
8000.	0.6999E 01	50000.	0.1602E 01	300000.	0.1134E 03
10000.	0.7250E 01	60000.	0.1190E 01	400000.	0.5003E 02

[a]Wave numbers in table are photon wave numbers.

TABLE V. - Continued. ABSORPTION COEFFICIENTS AND OPACITY OF HYDROGEN AT 500 ATMOSPHERES (5.066×10^7 N/m^2) PRESSURE[a]

(i) Temperature, 26 000° R (14 444 K)

PRESSURE	0.5066E 08 N/M2	TOTAL NUMBER DENSITY	0.2549E 27 1/M3
TEMPERATURE	26000. R	H IONIZATION POTENTIAL	105026. 1/CM
TEMPERATURE	14444. K	PLANCK MEAN OPACITY	0.1533E 02 1/CM
DENSITY	0.4208E-03 G/CM3	ROSSELAND MEAN OPACITY	0.2701E 01 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	2.416E 26	H2(EXCITED STATES)	1.105E 22
H(EXCITED STATES)	5.111E 23	H-	1.440E 23
H+	5.385E 24	H2+	1.330E 23
E	5.376E 24	H3+	1.879E 21
H2(GROUND STATE)	1.791E 24		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.1104E 04	11000.	0.1300E 02	70000.	0.1485E 01
1500.	0.3715E 03	12000.	0.1179E 02	75000.	0.1318E 01
2000.	0.2023E 03	13500.	0.1034E 02	80000.	0.1182E 01
2500.	0.1390E 03	15000.	0.9164E 01	90000.	0.9873E 00
3000.	0.9555E 02	20000.	0.6465E 01	100000.	0.8451E 00
4000.	0.5279E 02	25000.	0.9107E 01	125000.	0.1066E 04
5000.	0.3324E 02	27500.	0.7895E 01	150000.	0.6597E 03
5500.	0.2726E 02	30000.	0.6742E 01	175000.	0.4330E 03
6000.	0.2273E 02	40000.	0.3993E 01	200000.	0.3002E 03
8000.	0.1947E 02	50000.	0.2692E 01	300000.	0.9657E 02
10000.	0.1453E 02	60000.	0.1952E 01	400000.	0.4271E 02

(j) Temperature, 30 000° R (16 667 K)

PRESSURE	0.5066E 08 N/M2	TOTAL NUMBER DENSITY	0.2224E 27 1/M3
TEMPERATURE	30000. R	H IONIZATION POTENTIAL	103330. 1/CM
TEMPERATURE	16667. K	PLANCK MEAN OPACITY	0.2996E 02 1/CM
DENSITY	0.3542E-03 G/CM3	ROSSELAND MEAN OPACITY	0.3170E 01 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	1.965E 26	H2(EXCITED STATES)	1.675E 22
H(EXCITED STATES)	1.349E 24	H-	1.889E 23
H+	1.168E 25	H2+	1.737E 23
E	1.167E 25	H3+	1.443E 21
H2(GROUND STATE)	7.748E 23		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.5452E 04	11000.	0.2692E 02	70000.	0.1971E 01
1500.	0.1287E 04	12000.	0.2348E 02	75000.	0.1685E 01
2000.	0.6208E 03	13500.	0.1960E 02	80000.	0.1456E 01
2500.	0.3609E 03	15000.	0.1669E 02	90000.	0.1128E 01
3000.	0.2444E 03	20000.	0.1078E 02	100000.	0.8931E 00
4000.	0.1329E 03	25000.	0.1762E 02	125000.	0.8632E 03
5000.	0.8283E 02	27500.	0.1448E 02	150000.	0.5310E 03
5500.	0.6764E 02	30000.	0.1209E 02	175000.	0.3483E 03
6000.	0.7999E 02	40000.	0.6600E 01	200000.	0.2412E 03
8000.	0.4607E 02	50000.	0.4123E 01	300000.	0.7766E 02
10000.	0.3139E 02	60000.	0.2783E 01	400000.	0.3440E 02

[a]Wave numbers in table are photon wave numbers.

TABLE V. - Continued. ABSORPTION COEFFICIENTS AND OPACITY OF HYDROGEN AT 500 ATMOSPHERES (5.066×10^7 N/m^2) PRESSURE[a]

(k) Temperature, 40 000° R (22 222 K)

PRESSURE	0.5066E 08 N/M2	TOTAL NUMBER DENSITY	0.1722E 27 1/M3
TEMPERATURE	40000. R	H IONIZATION POTENTIAL	100263. 1/CM
TEMPERATURE	22222. K	PLANCK MEAN OPACITY	0.5780E 02 1/CM
DENSITY	0.2307E-03 G/CM3	ROSSELAND MEAN OPACITY	0.4629E 01 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	9.895E 25	H2(EXCITED STATES)	1.227E 22
H(EXCITED STATES)	3.581E 24	H-	1.603E 23
H+	3.463E 25	H2+	1.484E 23
E	3.462E 25	H3+	3.806E 20
H2(GROUND STATE)	9.492E 22		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.1840E 05	11000.	0.7886E 02	70000.	0.3475E 01
1500.	0.1220E 05	12000.	0.6582E 02	75000.	0.2919E 01
2000.	0.3892E 04	13500.	0.5155E 02	80000.	0.2480E 01
2500.	0.1735E 04	15000.	0.4144E 02	90000.	0.1852E 01
3000.	0.1316E 04	20000.	0.6757E 02	100000.	0.1424E 01
4000.	0.6756E 03	25000.	0.4109E 02	125000.	0.4334E 03
5000.	0.4175E 03	27500.	0.3307E 02	150000.	0.2652E 03
5500.	0.3404E 03	30000.	0.2706E 02	175000.	0.1739E 03
6000.	0.2824E 03	40000.	0.1372E 02	200000.	0.1203E 03
8000.	0.1535E 03	50000.	0.8009E 01	300000.	0.3876E 02
10000.	0.9618E 02	60000.	0.5116E 01	400000.	0.1719E 02

(l) Temperature, 50 000° R (27 778 K)

PRESSURE	0.5066E 08 N/M2	TOTAL NUMBER DENSITY	0.1406E 27 1/M3
TEMPERATURE	50000. R	H IONIZATION POTENTIAL	99651. 1/CM
TEMPERATURE	27778. K	PLANCK MEAN OPACITY	0.6247E 02 1/CM
DENSITY	0.1530E-03 G/CM3	ROSSELAND MEAN OPACITY	0.6042E 01 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	3.789E 25	H2(EXCITED STATES)	3.429E 21
H(EXCITED STATES)	4.117E 24	H-	5.764E 22
H+	4.926E 25	H2+	5.400E 22
E	4.926E 25	H3+	3.430E 19
H2(GROUND STATE)	8.559E 21		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.2317E 05	11000.	0.9559E 02	70000.	0.3210E 01
1500.	0.1826E 05	12000.	0.7899E 02	75000.	0.2668E 01
2000.	0.9818E 04	13500.	0.6091E 02	80000.	0.2243E 01
2500.	0.3312E 04	15000.	0.4820E 02	90000.	0.1636E 01
3000.	0.1835E 04	20000.	0.6937E 02	100000.	0.2991E 03
4000.	0.8895E 03	25000.	0.4192E 02	125000.	0.1660E 03
5000.	0.5335E 03	27500.	0.3361E 02	150000.	0.1015E 03
5500.	0.4323E 03	30000.	0.2738E 02	175000.	0.6656E 02
6000.	0.3573E 03	40000.	0.1360E 02	200000.	0.4604E 02
8000.	0.1912E 03	50000.	0.7746E 01	300000.	0.1483E 02
10000.	0.1177E 03	60000.	0.4829E 01	400000.	0.6583E 01

[a]Wave numbers in table are photon wave numbers.

TABLE V. - Continued. ABSORPTION COEFFICIENTS AND OPACITY OF HYDROGEN AT 500 ATMOSPHERES (5.066×10^7 N/m^2) PRESSURE[a]

(m) Temperature, 60 000° R (33 333 K)

PRESSURE	0.5066E 08 N/M2	TOTAL NUMBER DENSITY	0.1168E 27 1/M3
TEMPERATURE	60000. R	H IONIZATION POTENTIAL	100448. 1/CM
TEMPERATURE	33333. K	PLANCK MEAN OPACITY	0.2148E 02 1/CM
DENSITY	0.1115E-03 G/CM3	ROSSELAND MEAN OPACITY	0.3273E 01 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	1.307E 25	H2(EXCITED STATES)	5.804E 20
H(EXCITED STATES)	3.386E 24	H-	1.459E 22
H+	5.013E 25	H2+	1.382E 22
E	5.013E 25	H3+	2.043E 18
H2(GROUND STATE)	7.079E 20		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.2324E 05	11000.	0.7459E 02	70000.	0.2193E 01
1500.	0.1843E 05	12000.	0.6161E 02	75000.	0.1818E 01
2000.	0.9670E 04	13500.	0.4748E 02	80000.	0.1524E 01
2500.	0.2341E 04	15000.	0.3753E 02	90000.	0.1102E 01
3000.	0.1422E 04	20000.	0.4730E 02	100000.	0.8229E 00
4000.	0.6878E 03	25000.	0.2870E 02	125000.	0.5729E 02
5000.	0.4141E 03	27500.	0.2305E 02	150000.	0.3508E 02
5500.	0.3358E 03	30000.	0.1880E 02	175000.	0.2302E 02
6000.	0.2778E 03	40000.	0.9372E 01	200000.	0.1593E 02
8000.	0.1490E 03	50000.	0.5332E 01	300000.	0.5131E 01
10000.	0.9184E 02	60000.	0.3313E 01	400000.	0.2277E 01

(n) Temperature, 70 000° R (38 889 K)

PRESSURE	0.5066E 08 N/M2	TOTAL NUMBER DENSITY	0.9898E 26 1/M3
TEMPERATURE	70000. R	H IONIZATION POTENTIAL	101512. 1/CM
TEMPERATURE	38889. K	PLANCK MEAN OPACITY	0.9685E 01 1/CM
DENSITY	0.8901E-04 G/CM3	ROSSELAND MEAN OPACITY	0.2224E 01 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	4.846E 24	H2(EXCITED STATES)	1.388E 20
H(EXCITED STATES)	2.546E 24	H-	3.773E 21
H+	4.579E 25	H2+	3.605E 21
E	4.579E 25	H3+	1.445E 17
H2(GROUND STATE)	7.269E 19		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.2186E 05	11000.	0.4941E 02	70000.	0.1374E 01
1500.	0.1674E 05	12000.	0.4088E 02	75000.	0.1141E 01
2000.	0.6266E 04	13500.	0.3157E 02	80000.	0.9569E 00
2500.	0.1420E 04	15000.	0.2501E 02	90000.	0.6921E 00
3000.	0.7830E 03	20000.	0.2854E 02	100000.	0.5162E 00
4000.	0.3719E 03	25000.	0.1743E 02	125000.	0.2124E 02
5000.	0.2703E 03	27500.	0.1403E 02	150000.	0.1304E 02
5500.	0.2197E 03	30000.	0.1148E 02	175000.	0.8567E 01
6000.	0.1820E 03	40000.	0.5779E 01	200000.	0.5929E 01
8000.	0.9818E 02	50000.	0.3312E 01	300000.	0.1910E 01
10000.	0.6074E 02	60000.	0.2068E 01	400000.	0.8477E 00

[a]Wave numbers in table are photon wave numbers.

TABLE V. - Concluded. ABSORPTION COEFFICIENTS AND OPACITY OF HYDROGEN AT 500 ATMOSPHERES (5.066×10^7 N/m^2) PRESSURE[a]

(o) Temperature, 80 000° R (44 444 K)

PRESSURE	0.5066E 08 N/M2	TOTAL NUMBER DENSITY	0.8576E 26 1/M3
TEMPERATURE	80000. R	H IONIZATION POTENTIAL	102456. 1/CM
TEMPERATURE	44444. K	PLANCK MEAN OPACITY	0.4490E 01 1/CM
DENSITY	0.7502E-04 G/CM3	ROSSELAND MEAN OPACITY	0.1378E 01 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	2.043E 24	H2(EXCITED STATES)	3.296E 19
H(EXCITED STATES)	1.858E 24	H-	1.131E 21
H+	4.093E 25	H2+	1.089E 21
E	4.093E 25	H3+	1.419E 16
H2(GROUND STATE)	1.014E 19		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.2023E 05	11000.	0.3240E 02	70000.	0.8735E 00
1500.	0.1464E 05	12000.	0.2685E 02	75000.	0.7268E 00
2000.	0.2748E 04	13500.	0.2079E 02	80000.	0.6110E 00
2500.	0.8571E 03	15000.	0.1650E 02	90000.	0.4433E 00
3000.	0.4966E 03	20000.	0.8687E 01	100000.	0.3313E 00
4000.	0.2424E 03	25000.	0.1067E 02	125000.	0.8948E 01
5000.	0.1746E 03	27500.	0.8619E 01	150000.	0.5513E 01
5500.	0.1422E 03	30000.	0.7070E 01	175000.	0.3628E 01
6000.	0.1181E 03	40000.	0.3596E 01	200000.	0.2513E 01
8000.	0.6401E 02	50000.	0.2079E 01	300000.	0.8102E 00
10000.	0.3976E 02	60000.	0.1307E 01	400000.	0.3594E 00

(p) Temperature 90 000° R (50 000 K)

PRESSURE	0.5066E 08 N/M2	TOTAL NUMBER DENSITY	0.7566E 26 1/M3
TEMPERATURE	90000. R	H IONIZATION POTENTIAL	103237. 1/CM
TEMPERATURE	50000. K	PLANCK MEAN OPACITY	0.2237E 01 1/CM
DENSITY	0.6531E-04 G/CM3	ROSSELAND MEAN OPACITY	0.7816E 00 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	9.702E 23	H2(EXCITED STATES)	9.754E 18
H(EXCITED STATES)	1.429E 24	H-	3.939E 20
H+	3.663E 25	H2+	3.815E 20
E	3.663E 25	H3+	1.892E 15
H2(GROUND STATE)	1.856E 18		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.1871E 05	11000.	0.2190E 02	70000.	0.5772E 00
1500.	0.1251E 05	12000.	0.1817E 02	75000.	0.4816E 00
2000.	0.1358E 04	13500.	0.1410E 02	80000.	0.4057E 00
2500.	0.5443E 03	15000.	0.1122E 02	90000.	0.2956E 00
3000.	0.3269E 03	20000.	0.5944E 01	100000.	0.2216E 00
4000.	0.1633E 03	25000.	0.6810E 01	125000.	0.4242E 01
5000.	0.9898E 02	27500.	0.5513E 01	150000.	0.2625E 01
5500.	0.8030E 02	30000.	0.4533E 01	175000.	0.1731E 01
6000.	0.7904E 02	40000.	0.2327E 01	200000.	0.1201E 01
8000.	0.4305E 02	50000.	0.1356E 01	300000.	0.3875E 00
10000.	0.2683E 02	60000.	0.8588E 00	400000.	0.1719E 00

[a]Wave numbers in table are photon wave numbers.

TABLE VI. - ABSORPTION COEFFICIENTS AND OPACITY OF HYDROGEN

AT 750 ATMOSPHERES (7.599×10^7 N/m^2) PRESSURE[a]

(a) Temperature, 3000° R (1667 K)

PRESSURE	0.7599E 08 N/M2	TOTAL NUMBER DENSITY	0.3303E 28 1/M3
TEMPERATURE	3000. R	H IONIZATION POTENTIAL	109679. 1/CM
TEMPERATURE	1667. K	PLANCK MEAN OPACITY	0.1845E-01 1/CM
DENSITY	0.1105E-01 G/CM3	ROSSELAND MEAN OPACITY	0.7924E-10 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	1.287E 22	H2(EXCITED STATES)	0.
H(EXCITED STATES)	7.437E-09	H-	7.172E 06
H+	0.	H2+	0.
E	1.706E 09	H3+	1.713E 09
H2(GROUND STATE)	3.303E 27		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.2289E-01	11000.	0.3086E-05	70000.	0.1511E-15
1500.	0.3310E-01	12000.	0.6011E-06	75000.	0.1344E-15
2000.	0.2081E-01	13500.	0.5102E-07	80000.	0.1205E-15
2500.	0.7427E-02	15000.	0.4277E-08	90000.	0.9928E-16
3000.	0.6570E-02	20000.	0.1036E-11	100000.	0.8330E-16
4000.	0.3868E-01	25000.	0.1036E-14	125000.	0.1809E 05
5000.	0.3132E-01	27500.	0.6913E-15	150000.	0.2775E 05
5500.	0.2029E-01	30000.	0.5989E-15	175000.	0.1900E 05
6000.	0.9276E-02	40000.	0.5250E-15	200000.	0.1454E 05
8000.	0.3943E-03	50000.	0.1736E-12	300000.	0.4423E 04
10000.	0.1571E-04	60000.	0.3156E-10	400000.	0.1693E 04

(b) Temperature, 5000° R (2778 K)

PRESSURE	0.7599E 08 N/M2	TOTAL NUMBER DENSITY	0.1982E 28 1/M3
TEMPERATURE	5000. R	H IONIZATION POTENTIAL	109679. 1/CM
TEMPERATURE	2778. K	PLANCK MEAN OPACITY	0.4822E-02 1/CM
DENSITY	0.6623E-02 G/CM3	ROSSELAND MEAN OPACITY	0.4735E-06 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	5.443E 24	H2(EXCITED STATES)	8.076E 07
H(EXCITED STATES)	6.823E 06	H-	1.040E 15
H+	3.795E 10	H2+	7.681E 10
E	1.078E 16	H3+	1.182E 16
H2(GROUND STATE)	1.976E 27		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.6016E-02	11000.	0.1529E-04	70000.	0.6391E-08
1500.	0.1063E-01	12000.	0.4635E-05	75000.	0.5583E-08
2000.	0.1126E-01	13500.	0.8004E-06	80000.	0.4920E-08
2500.	0.7107E-02	15000.	0.1720E-06	90000.	0.3961E-08
3000.	0.5885E-02	20000.	0.3971E-07	100000.	0.3228E-08
4000.	0.1404E-01	25000.	0.3051E-07	125000.	0.1085E 05
5000.	0.1243E-01	27500.	0.2721E-07	150000.	0.1662E 05
5500.	0.8901E-02	30000.	0.2444E-07	175000.	0.1138E 05
6000.	0.5261E-02	40000.	0.3254E-07	200000.	0.8704E 04
8000.	0.5310E-03	50000.	0.1162E-05	300000.	0.2649E 04
10000.	0.5036E-04	60000.	0.3092E-04	400000.	0.1014E 04

[a]Wave numbers in table are photon wave numbers.

TABLE VI. - Continued. ABSORPTION COEFFICIENTS AND OPACITY OF HYDROGEN AT 750 ATMOSPHERES (7.599×10^7 N/m^2) PRESSURE[a]

(c) Temperature, 7000° R (3889 K)

PRESSURE	0.7599E 08 N/M2	TOTAL NUMBER DENSITY	0.1415E 28 1/M3
TEMPERATURE	7000. R	H IONIZATION POTENTIAL	109666. 1/CM
TEMPERATURE	3889. K	PLANCK MEAN OPACITY	0.3744E-03 1/CM
DENSITY	0.4628E-02 G/CM3	ROSSELAND MEAN OPACITY	0.1003E-03 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	6.565E 25	H2(EXCITED STATES)	5.205E 13
H(EXCITED STATES)	1.602E 13	H-	2.386E 18
H+	1.079E 16	H2+	1.264E 16
E	8.522E 18	H3+	1.088E 19
H2(GROUND STATE)	1.350E 27		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.3792E-02	11000.	0.1169E-03	70000.	0.1382E-04
1500.	0.4592E-02	12000.	0.1176E-03	75000.	0.1205E-04
2000.	0.5141E-02	13500.	0.1140E-03	80000.	0.1061E-04
2500.	0.4017E-02	15000.	0.1076E-03	90000.	0.8522E-05
3000.	0.3023E-02	20000.	0.8312E-04	100000.	0.6927E-05
4000.	0.7649E-03	25000.	0.6521E-04	125000.	0.7679E 04
5000.	0.2205E-03	27500.	0.5859E-04	150000.	0.1152E 05
5500.	0.1292E-03	30000.	0.5328E-04	175000.	0.7878E 04
6000.	0.8176E-04	40000.	0.7260E-04	200000.	0.6020E 04
8000.	0.8833E-04	50000.	0.8792E-03	300000.	0.1833E 04
10000.	0.1125E-03	60000.	0.9510E-02	400000.	0.7034E 03

(d) Temperature, 10 000° R (5556 K)

PRESSURE	0.7599E 08 N/M2	TOTAL NUMBER DENSITY	0.9908E 27 1/M3
TEMPERATURE	10000. R	H IONIZATION POTENTIAL	109550. 1/CM
TEMPERATURE	5556. K	PLANCK MEAN OPACITY	0.1896E-01 1/CM
DENSITY	0.2763E-02 G/CM3	ROSSELAND MEAN OPACITY	0.1598E-01 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	3.306E 26	H2(EXCITED STATES)	8.906E 17
H(EXCITED STATES)	7.700E 17	H-	4.815E 20
H+	1.355E 20	H2+	9.263E 19
E	1.163E 21	H3+	1.416E 21
H2(GROUND STATE)	6.603E 26		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.2845E 00	11000.	0.2241E-01	70000.	0.2965E-02
1500.	0.1262E 00	12000.	0.2278E-01	75000.	0.2620E-02
2000.	0.7088E-01	13500.	0.2236E-01	80000.	0.2338E-02
2500.	0.4526E-01	15000.	0.2127E-01	90000.	0.1935E-02
3000.	0.3135E-01	20000.	0.1672E-01	100000.	0.1628E-02
4000.	0.1755E-01	25000.	0.1330E-01	125000.	0.5060E 04
5000.	0.1117E-01	27500.	0.1203E-01	150000.	0.6429E 04
5500.	0.9214E-02	30000.	0.1113E-01	175000.	0.4376E 04
6000.	0.7726E-02	40000.	0.1461E-01	200000.	0.3306E 04
8000.	0.1571E-01	50000.	0.7808E-01	300000.	0.1013E 04
10000.	0.2127E-01	60000.	0.4076E 00	400000.	0.3957E 03

[a]Wave numbers in table are photon wave numbers.

TABLE VI. - Continued. ABSORPTION COEFFICIENTS AND OPACITY OF HYDROGEN AT 750 ATMOSPHERES (7.599×10^7 N/m^2) PRESSURE[a]

(e) Temperature, 13 000° R (7222 K)

PRESSURE	0.7599E 08 N/M2	TOTAL NUMBER DENSITY	0.7622E 27 1/M3
TEMPERATURE	13000. R	H IONIZATION POTENTIAL	109223. 1/CM
TEMPERATURE	7222. K	PLANCK MEAN OPACITY	0.2529E 00 1/CM
DENSITY	0.1650E-02 G/CM3	ROSSELAND MEAN OPACITY	0.2027E 00 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	5.384E 26	H2(EXCITED STATES)	9.011E 19
H(EXCITED STATES)	1.832E 20	H-	6.321E 21
H+	1.405E 22	H2+	5.194E 21
E	2.015E 22	H3+	7.226E 21
H2(GROUND STATE)	2.237E 26		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.5180E 01	11000.	0.3004E 00	70000.	0.4739E-01
1500.	0.2305E 01	12000.	0.3053E 00	75000.	0.4299E-01
2000.	0.1299E 01	13500.	0.3004E 00	80000.	0.3941E-01
2500.	0.8334E 00	15000.	0.2872E 00	90000.	0.3433E-01
3000.	0.5807E 00	20000.	0.2303E 00	100000.	0.3049E-01
4000.	0.3298E 00	25000.	0.1868E 00	125000.	0.3578E 04
5000.	0.2137E 00	27500.	0.1667E 00	150000.	0.3316E 04
5500.	0.1780E 00	30000.	0.1543E 00	175000.	0.2228E 04
6000.	0.1509E 00	40000.	0.1597E 00	200000.	0.1636E 04
8000.	0.2250E 00	50000.	0.4353E 00	300000.	0.5094E 03
10000.	0.2869E 00	60000.	0.1397E 01	400000.	0.2078E 03

(f) Temperature, 16 000° R (8889 K)

PRESSURE	0.7599E 08 N/M2	TOTAL NUMBER DENSITY	0.6193E 27 1/M3
TEMPERATURE	16000. R	H IONIZATION POTENTIAL	108561. 1/CM
TEMPERATURE	8889. K	PLANCK MEAN OPACITY	0.1294E 01 1/CM
DENSITY	0.1150E-02 G/CM3	ROSSELAND MEAN OPACITY	0.8686E 00 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	5.511E 26	H2(EXCITED STATES)	9.763E 20
H(EXCITED STATES)	4.441E 21	H-	3.080E 22
H+	1.576E 23	H2+	3.013E 22
E	1.652E 23	H3+	8.309E 21
H2(GROUND STATE)	6.777E 25		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.3875E 02	11000.	0.1535E 01	70000.	0.2457E 00
1500.	0.1724E 02	12000.	0.1557E 01	75000.	0.2229E 00
2000.	0.9722E 01	13500.	0.1522E 01	80000.	0.2043E 00
2500.	0.6244E 01	15000.	0.1452E 01	90000.	0.1778E 00
3000.	0.4355E 01	20000.	0.1172E 01	100000.	0.1578E 00
4000.	0.2480E 01	25000.	0.9534E 00	125000.	0.2780E 04
5000.	0.1614E 01	27500.	0.8699E 00	150000.	0.2040E 04
5500.	0.1347E 01	30000.	0.7925E 00	175000.	0.1354E 04
6000.	0.1148E 01	40000.	0.6457E 00	200000.	0.9651E 03
8000.	0.1286E 01	50000.	0.9325E 00	300000.	0.3056E 03
10000.	0.1491E 01	60000.	0.1870E 01	400000.	0.1301E 03

[a]Wave numbers in table are photon wave numbers.

TABLE VI. - Continued. ABSORPTION COEFFICIENTS AND OPACITY OF HYDROGEN AT 750 ATMOSPHERES (7.599×10^7 N/m^2) PRESSURE[a]

(g) Temperature, 20 000° R (11 111 K)

PRESSURE	0.7599E 08 N/M2	TOTAL NUMBER DENSITY	0.4956E 27 1/M3
TEMPERATURE	20000. R	H IONIZATION POTENTIAL	107175. 1/CM
TEMPERATURE	11111. K	PLANCK MEAN OPACITY	0.5494E 01 1/CM
DENSITY	0.8574E-03 G/CM3	ROSSELAND MEAN OPACITY	0.2088E 01 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	4.752E 26	H2(EXCITED STATES)	5.729E 21
H(EXCITED STATES)	6.344E 22	H-	1.057E 23
H+	1.122E 24	H2+	1.005E 23
E	1.124E 24	H3+	6.946E 21
H2(GROUND STATE)	1.781E 25		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.2331E 03	11000.	0.6115E 01	70000.	0.8903E 00
1500.	0.1032E 03	12000.	0.5975E 01	75000.	0.8020E 00
2000.	0.5796E 02	13500.	0.5695E 01	80000.	0.7300E 00
2500.	0.3711E 02	15000.	0.5362E 01	90000.	0.6264E 00
3000.	0.2582E 02	20000.	0.4254E 01	100000.	0.5485E 00
4000.	0.1462E 02	25000.	0.4172E 01	125000.	0.2174E 04
5000.	0.9604E 01	27500.	0.3490E 01	150000.	0.1418E 04
5500.	0.7990E 01	30000.	0.3095E 01	175000.	0.9338E 03
6000.	0.6766E 01	40000.	0.2042E 01	200000.	0.6534E 03
8000.	0.5797E 01	50000.	0.1480E 01	300000.	0.2091E 03
10000.	0.6216E 01	60000.	0.1129E 01	400000.	0.9132E 02

(h) Temperature, 23 000° R (12 778 K)

PRESSURE	0.7599E 08 N/M2	TOTAL NUMBER DENSITY	0.4313E 27 1/M3
TEMPERATURE	23000. R	H IONIZATION POTENTIAL	105859. 1/CM
TEMPERATURE	12778. K	PLANCK MEAN OPACITY	0.1252E 02 1/CM
DENSITY	0.7302E-03 G/CM3	ROSSELAND MEAN OPACITY	0.3406E 01 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	4.164E 26	H2(EXCITED STATES)	1.312E 22
H(EXCITED STATES)	2.498E 23	H-	1.868E 23
H+	3.111E 24	H2+	1.743E 23
E	3.105E 24	H3+	6.115E 21
H2(GROUND STATE)	8.020E 24		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.7331E 03	11000.	0.1213E 02	70000.	0.1686E 01
1500.	0.2808E 03	12000.	0.1147E 02	75000.	0.1509E 01
2000.	0.1561E 03	13500.	0.1056E 02	80000.	0.1366E 01
2500.	0.9919E 02	15000.	0.9698E 01	90000.	0.1160E 01
3000.	0.6848E 02	20000.	0.7314E 01	100000.	0.1006E 01
4000.	0.3946E 02	25000.	0.8269E 01	125000.	0.1864E 04
5000.	0.2505E 02	27500.	0.7412E 01	150000.	0.1179E 04
5500.	0.2063E 02	30000.	0.6475E 01	175000.	0.7747E 03
6000.	0.1727E 02	40000.	0.4101E 01	200000.	0.5392E 03
8000.	0.1259E 02	50000.	0.2894E 01	300000.	0.1731E 03
10000.	0.1288E 02	60000.	0.2166E 01	400000.	0.7614E 02

[a]Wave numbers in table are photon wave numbers.

TABLE VI. - Continued. ABSORPTION COEFFICIENTS AND OPACITY OF HYDROGEN AT 750 ATMOSPHERES (7.599×10^7 N/m^2) PRESSURE[a]

(i) Temperature, 26 000° R (14 444 K)

PRESSURE	0.7599E 08 N/M2	TOTAL NUMBER DENSITY	0.3823E 27 1/M3
TEMPERATURE	26000. R	H IONIZATION POTENTIAL	104413. 1/CM
TEMPERATURE	14444. K	PLANCK MEAN OPACITY	0.2513E 02 1/CM
DENSITY	0.6357E-03 G/CM3	ROSSELAND MEAN OPACITY	0.4918E 01 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	3.634E 26	H2(EXCITED STATES)	2.333E 22
H(EXCITED STATES)	7.100E 23	H-	2.739E 23
H+	6.812E 24	H2+	2.531E 23
E	6.797E 24	H3+	5.380E 21
H2(GROUND STATE)	4.053E 24		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.2207E 04	11000.	0.2282E 02	70000.	0.2714E 01
1500.	0.7407E 03	12000.	0.2087E 02	75000.	0.2415E 01
2000.	0.3825E 03	13500.	0.1849E 02	80000.	0.2173E 01
2500.	0.2408E 03	15000.	0.1653E 02	90000.	0.1824E 01
3000.	0.1653E 03	20000.	0.1186E 02	100000.	0.1568E 01
4000.	0.9131E 02	25000.	0.1540E 02	125000.	0.1611E 04
5000.	0.5756E 02	27500.	0.1352E 02	150000.	0.1004E 04
5500.	0.4724E 02	30000.	0.1163E 02	175000.	0.6592E 03
6000.	0.3943E 02	40000.	0.7051E 01	200000.	0.4576E 03
8000.	0.3309E 02	50000.	0.4829E 01	300000.	0.1471E 03
10000.	0.2525E 02	60000.	0.3540E 01	400000.	0.6495E 02

(j) Temperature, 30 000° R (16 667 K)

PRESSURE	0.7599E 08 N/M2	TOTAL NUMBER DENSITY	0.3335E 27 1/M3
TEMPERATURE	30000. R	H IONIZATION POTENTIAL	102465. 1/CM
TEMPERATURE	16667. K	PLANCK MEAN OPACITY	0.4767E 02 1/CM
DENSITY	0.5366E-03 G/CM3	ROSSELAND MEAN OPACITY	0.5671E 01 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	2.991E 26	H2(EXCITED STATES)	3.568E 22
H(EXCITED STATES)	1.871E 24	H-	3.682E 23
H+	1.497E 25	H2+	3.389E 23
E	1.494E 25	H3+	4.283E 21
H2(GROUND STATE)	1.796E 24		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.8840E 04	11000.	0.4631E 02	70000.	0.3542E 01
1500.	0.2505E 04	12000.	0.4075E 02	75000.	0.3039E 01
2000.	0.1121E 04	13500.	0.3439E 02	80000.	0.2634E 01
2500.	0.6254E 03	15000.	0.2959E 02	90000.	0.2053E 01
3000.	0.4212E 03	20000.	0.1958E 02	100000.	0.1634E 01
4000.	0.2280E 03	25000.	0.2931E 02	125000.	0.1317E 04
5000.	0.1937E 03	27500.	0.2427E 02	150000.	0.8135E 03
5500.	0.1590E 03	30000.	0.2042E 02	175000.	0.5338E 03
6000.	0.1327E 03	40000.	0.1141E 02	200000.	0.3700E 03
8000.	0.7723E 02	50000.	0.7256E 01	300000.	0.1191E 03
10000.	0.5354E 02	60000.	0.4958E 01	400000.	0.5269E 02

[a]Wave numbers in table are photon wave numbers.

TABLE VI. - Continued. ABSORPTION COEFFICIENTS AND OPACITY OF HYDROGEN AT 750 ATMOSPHERES (7.599×10^7 N/m^2) PRESSURE[a]

(k) Temperature, 40 000° R (22 222 K)

PRESSURE	0.7599E 08 N/M2	TOTAL NUMBER DENSITY	0.2587E 27 1/M3
TEMPERATURE	40000. R	H IONIZATION POTENTIAL	98785. 1/CM
TEMPERATURE	22222. K	PLANCK MEAN OPACITY	0.1497E 03 1/CM
DENSITY	0.3565E-03 G/CM3	ROSSELAND MEAN OPACITY	0.1064E 02 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	1.602E 26	H2(EXCITED STATES)	2.889E 22
H(EXCITED STATES)	5.059E 24	H-	3.463E 23
H+	4.623E 25	H2+	3.208E 23
E	4.621E 25	H3+	1.332E 21
H2(GROUND STATE)	2.488E 23		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.2292E 05	11000.	0.1328E 03	70000.	0.6230E 01
1500.	0.1854E 05	12000.	0.1112E 03	75000.	0.5257E 01
2000.	0.1034E 05	13500.	0.8765E 02	80000.	0.4485E 01
2500.	0.4246E 04	15000.	0.7091E 02	90000.	0.3380E 01
3000.	0.2439E 04	20000.	0.1124E 03	100000.	0.1267E 04
4000.	0.1192E 04	25000.	0.6895E 02	125000.	0.7022E 03
5000.	0.7089E 03	27500.	0.5575E 02	150000.	0.4301E 03
5500.	0.5748E 03	30000.	0.4583E 02	175000.	0.2821E 03
6000.	0.4751E 03	40000.	0.2364E 02	200000.	0.1952E 03
8000.	0.2569E 03	50000.	0.1402E 02	300000.	0.6289E 02
10000.	0.1614E 03	60000.	0.9077E 01	400000.	0.2789E 02

(ℓ) Temperature, 50 000° R (27 778 K)

PRESSURE	0.7599E 08 N/M2	TOTAL NUMBER DENSITY	0.2124E 27 1/M3
TEMPERATURE	50000. R	H IONIZATION POTENTIAL	97793. 1/CM
TEMPERATURE	27778. K	PLANCK MEAN OPACITY	0.1123E 03 1/CM
DENSITY	0.2400E-03 G/CM3	ROSSELAND MEAN OPACITY	0.1134E 02 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	6.779E 25	H2(EXCITED STATES)	9.575E 21
H(EXCITED STATES)	6.003E 24	H-	1.447E 23
H+	6.914E 25	H2+	1.356E 23
E	6.913E 25	H3+	1.541E 20
H2(GROUND STATE)	2.740E 22		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.2984E 05	11000.	0.1721E 03	70000.	0.6007E 01
1500.	0.2556E 05	12000.	0.1422E 03	75000.	0.5009E 01
2000.	0.1931E 05	13500.	0.1097E 03	80000.	0.4225E 01
2500.	0.9962E 04	15000.	0.8688E 02	90000.	0.3102E 01
3000.	0.4229E 04	20000.	0.1248E 03	100000.	0.5353E 03
4000.	0.1756E 04	25000.	0.7566E 02	125000.	0.2970E 03
5000.	0.1003E 04	27500.	0.6077E 02	150000.	0.1817E 03
5500.	0.8042E 03	30000.	0.4961E 02	175000.	0.1192E 03
6000.	0.6593E 03	40000.	0.2486E 02	200000.	0.8244E 02
8000.	0.3469E 03	50000.	0.1428E 02	300000.	0.2656E 02
10000.	0.2122E 03	60000.	0.8974E 01	400000.	0.1179E 02

[a]Wave numbers in table are photon wave numbers.

TABLE VI. - Continued. ABSORPTION COEFFICIENTS AND OPACITY OF HYDROGEN AT 750 ATMOSPHERES (7.599×10^7 N/m^2) PRESSURE[a]

(m) Temperature, 60 000° R (33 333 K)

PRESSURE	0.7599E 08 N/M2	TOTAL NUMBER DENSITY	0.1768E 27 1/M3
TEMPERATURE	60000. R	H IONIZATION POTENTIAL	98540. 1/CM
TEMPERATURE	33333. K	PLANCK MEAN OPACITY	0.5684E 02 1/CM
DENSITY	0.1739E-03 G/CM3	ROSSELAND MEAN OPACITY	0.9391E 01 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	2.551E 25	H2(EXCITED STATES)	2.170E 21
H(EXCITED STATES)	5.308E 24	H-	4.144E 22
H+	7.297E 25	H2+	3.924E 22
E	7.297E 25	H3+	1.132E 19
H2(GROUND STATE)	2.695E 21		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.2962E 05	11000.	0.1458E 03	70000.	0.4343E 01
1500.	0.2627E 05	12000.	0.1203E 03	75000.	0.3606E 01
2000.	0.2021E 05	13500.	0.9252E 02	80000.	0.3028E 01
2500.	0.1042E 05	15000.	0.7306E 02	90000.	0.2197E 01
3000.	0.3728E 04	20000.	0.9218E 02	100000.	0.2006E 03
4000.	0.1489E 04	25000.	0.5599E 02	125000.	0.1118E 03
5000.	0.8555E 03	27500.	0.4498E 02	150000.	0.6847E 02
5500.	0.6825E 03	30000.	0.3672E 02	175000.	0.4493E 02
6000.	0.5596E 03	40000.	0.1836E 02	200000.	0.3109E 02
8000.	0.2945E 03	50000.	0.1049E 02	300000.	0.1002E 02
10000.	0.1800E 03	60000.	0.6539E 01	400000.	0.4446E 01

(n) Temperature, 70 000° R (38 889 K)

PRESSURE	0.7599E 08 N/M2	TOTAL NUMBER DENSITY	0.1499E 27 1/M3
TEMPERATURE	70000. R	H IONIZATION POTENTIAL	99735. 1/CM
TEMPERATURE	38889. K	PLANCK MEAN OPACITY	0.2582E 02 1/CM
DENSITY	0.1372E-03 G/CM3	ROSSELAND MEAN OPACITY	0.6536E 01 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	9.968E 24	H2(EXCITED STATES)	4.777E 20
H(EXCITED STATES)	4.142E 24	H-	1.150E 22
H+	6.787E 25	H2+	1.099E 22
E	6.787E 25	H3+	9.064E 17
H2(GROUND STATE)	3.076E 20		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.2808E 05	11000.	0.1042E 03	70000.	0.2866E 01
1500.	0.2407E 05	12000.	0.8605E 02	75000.	0.2381E 01
2000.	0.1775E 05	13500.	0.6636E 02	80000.	0.1999E 01
2500.	0.6850E 04	15000.	0.5251E 02	90000.	0.1448E 01
3000.	0.2409E 04	20000.	0.5923E 02	100000.	0.7794E 02
4000.	0.1019E 04	25000.	0.3616E 02	125000.	0.4370E 02
5000.	0.5936E 03	27500.	0.2912E 02	150000.	0.2683E 02
5500.	0.4776E 03	30000.	0.2383E 02	175000.	0.1763E 02
6000.	0.3929E 03	40000.	0.1201E 02	200000.	0.1220E 02
8000.	0.2087E 03	50000.	0.6891E 01	300000.	0.3932E 01
10000.	0.1283E 03	60000.	0.4309E 01	400000.	0.1745E 01

[a]Wave numbers in table are photon wave numbers.

TABLE VI. - Concluded. ABSORPTION COEFFICIENTS AND OPACITY OF HYDROGEN AT 750 ATMOSPHERES (7.599×10^7 N/m^2) PRESSURE[a]

(o) Temperature, 80 000° R (44 444 K)

PRESSURE	0.7599E 08 N/M2	TOTAL NUMBER DENSITY	0.1297E 27 1/M3
TEMPERATURE	80000. R	H IONIZATION POTENTIAL	100856. 1/CM
TEMPERATURE	44444. K	PLANCK MEAN OPACITY	0.9629E 01 1/CM
DENSITY	0.1148E-03 G/CM3	ROSSELAND MEAN OPACITY	0.2940E 01 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	4.320E 24	H2(EXCITED STATES)	1.236E 20
H(EXCITED STATES)	3.185E 24	H-	3.569E 21
H+	6.108E 25	H2+	3.435E 21
E	6.108E 25	H3+	9.470E 16
H2(GROUND STATE)	4.533E 19		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.2626E 05	11000.	0.7033E 02	70000.	0.1870E 01
1500.	0.2206E 05	12000.	0.5822E 02	75000.	0.1556E 01
2000.	0.1496E 05	13500.	0.4501E 02	80000.	0.1309E 01
2500.	0.3260E 04	15000.	0.3570E 02	90000.	0.9501E 00
3000.	0.1332E 04	20000.	0.3716E 02	100000.	0.7106E 00
4000.	0.6626E 03	25000.	0.2280E 02	125000.	0.1892E 02
5000.	0.3922E 03	27500.	0.1841E 02	150000.	0.1166E 02
5500.	0.3168E 03	30000.	0.1510E 02	175000.	0.7675E 01
6000.	0.2614E 03	40000.	0.7684E 01	200000.	0.5316E 01
8000.	0.1399E 03	50000.	0.4444E 01	300000.	0.1714E 01
10000.	0.8645E 02	60000.	0.2797E 01	400000.	0.7604E 00

(p) Temperature, 90 000° R (50 000 K)

PRESSURE	0.7599E 08 N/M2	TOTAL NUMBER DENSITY	0.1142E 27 1/M3
TEMPERATURE	90000. R	H IONIZATION POTENTIAL	101796. 1/CM
TEMPERATURE	50000. K	PLANCK MEAN OPACITY	0.4862E 01 1/CM
DENSITY	0.9939E-04 G/CM3	ROSSELAND MEAN OPACITY	0.1686E 01 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	2.087E 24	H2(EXCITED STATES)	3.647E 19
H(EXCITED STATES)	2.451E 24	H-	1.269E 21
H+	5.485E 25	H2+	1.229E 21
E	5.485E 25	H3+	1.311E 16
H2(GROUND STATE)	8.591E 18		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.2454E 05	11000.	0.4779E 02	70000.	0.1248E 01
1500.	0.2007E 05	12000.	0.3962E 02	75000.	0.1041E 01
2000.	0.1186E 05	13500.	0.3070E 02	80000.	0.8775E 00
2500.	0.1762E 04	15000.	0.2440E 02	90000.	0.6394E 00
3000.	0.8462E 03	20000.	0.2387E 02	100000.	0.4796E 00
4000.	0.3822E 03	25000.	0.1472E 02	125000.	0.9127E 01
5000.	0.2621E 03	27500.	0.1191E 02	150000.	0.5647E 01
5500.	0.2123E 03	30000.	0.9794E 01	175000.	0.3725E 01
6000.	0.1756E 03	40000.	0.5027E 01	200000.	0.2584E 01
8000.	0.9455E 02	50000.	0.2930E 01	300000.	0.8338E 00
10000.	0.5864E 02	60000.	0.1856E 01	400000.	0.3698E 00

[a]Wave numbers in table are photon wave numbers.

TABLE VII. - ABSORPTION COEFFICIENTS AND OPACITY OF HYDROGEN

AT 1000 ATMOSPHERES (10.13×10^7 N/m^2) PRESSURE[a]

(a) Temperature, 3000° R (1667 K)

PRESSURE	0.1013E 09 N/M2	TOTAL NUMBER DENSITY	0.4404E 28 1/M3
TEMPERATURE	3000. R	H IONIZATION POTENTIAL	109679. 1/CM
TEMPERATURE	1667. K	PLANCK MEAN OPACITY	0.3280E-01 1/CM
DENSITY	0.1474E-01 G/CM3	ROSSELAND MEAN OPACITY	0.1316E-09 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	1.486E 22	H2(EXCITED STATES)	0.
H(EXCITED STATES)	8.587E-09	H-	1.027E 07
H+	0.	H2+	0.
E	2.116E 09	H3+	2.127E 09
H2(GROUND STATE)	4.404E 27		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.4068E-01	11000.	0.5486E-05	70000.	0.2409E-15
1500.	0.5885E-01	12000.	0.1069E-05	75000.	0.2145E-15
2000.	0.3700E-01	13500.	0.9070E-07	80000.	0.1925E-15
2500.	0.1320E-01	15000.	0.7603E-08	90000.	0.1587E-15
3000.	0.1168E-01	20000.	0.1842E-11	100000.	0.1333E-15
4000.	0.6876E-01	25000.	0.1700E-14	125000.	0.2412E 05
5000.	0.5568E-01	27500.	0.1106E-14	150000.	0.3700E 05
5500.	0.3607E-01	30000.	0.9568E-15	175000.	0.2533E 05
6000.	0.1649E-01	40000.	0.7982E-15	200000.	0.1938E 05
8000.	0.7009E-03	50000.	0.2315E-12	300000.	0.5897E 04
10000.	0.2793E-04	60000.	0.4208E-10	400000.	0.2258E 04

(b) Temperature, 5000° R (2778 K)

PRESSURE	0.1013E 09 N/M2	TOTAL NUMBER DENSITY	0.2642E 28 1/M3
TEMPERATURE	5000. R	H IONIZATION POTENTIAL	109678. 1/CM
TEMPERATURE	2778. K	PLANCK MEAN OPACITY	0.8579E-02 1/CM
DENSITY	0.8833E-02 G/CM3	ROSSELAND MEAN OPACITY	0.7163E-06 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	6.286E 24	H2(EXCITED STATES)	1.077E 08
H(EXCITED STATES)	7.879E 06	H-	1.481E 15
H+	3.556E 10	H2+	8.311E 10
E	1.329E 16	H3+	1.477E 16
H2(GROUND STATE)	2.636E 27		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.1070E-01	11000.	0.2719E-04	70000.	0.9217E-08
1500.	0.1890E-01	12000.	0.8228E-05	75000.	0.8055E-08
2000.	0.2004E-01	13500.	0.1406E-05	80000.	0.7100E-08
2500.	0.1264E-01	15000.	0.2891E-06	90000.	0.5717E-08
3000.	0.1047E-01	20000.	0.5769E-07	100000.	0.4662E-08
4000.	0.2497E-01	25000.	0.4414E-07	125000.	0.1446E 05
5000.	0.2211E-01	27500.	0.3932E-07	150000.	0.2216E 05
5500.	0.1584E-01	30000.	0.3529E-07	175000.	0.1517E 05
6000.	0.9359E-02	40000.	0.4516E-07	200000.	0.1161E 05
8000.	0.9447E-03	50000.	0.1551E-05	300000.	0.3532E 04
10000.	0.8957E-04	60000.	0.4125E-04	400000.	0.1352E 04

[a]Wave numbers in table are photon wave numbers.

TABLE VII. - Continued. ABSORPTION COEFFICIENTS AND OPACITY OF HYDROGEN AT 1000 ATMOSPHERES (10.13×10^7 N/m^2) PRESSURE[a]

(c) Temperature, 7000° R (3889 K)

PRESSURE	0.1013E 09 N/M2	TOTAL NUMBER DENSITY	0.1887E 28 1/M3
TEMPERATURE	7000. R	H IONIZATION POTENTIAL	109665. 1/CM
TEMPERATURE	3889. K	PLANCK MEAN OPACITY	0.6410E-03 1/CM
DENSITY	0.6189E-02 G/CM3	ROSSELAND MEAN OPACITY	0.1471E-03 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	7.604E 25	H2(EXCITED STATES)	6.980E 13
H(EXCITED STATES)	1.853E 13	H-	3.387E 18
H+	1.020E 16	H2+	1.384E 16
E	1.045E 19	H3+	1.381E 19
H2(GROUND STATE)	1.811E 27		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.6494E-02	11000.	0.1685E-03	70000.	0.1970E-04
1500.	0.8121E-02	12000.	0.1690E-03	75000.	0.1718E-04
2000.	0.9175E-02	13500.	0.1636E-03	80000.	0.1512E-04
2500.	0.7180E-02	15000.	0.1540E-03	90000.	0.1215E-04
3000.	0.5407E-02	20000.	0.1188E-03	100000.	0.9879E-05
4000.	0.1357E-02	25000.	0.9306E-04	125000.	0.1025E 05
5000.	0.3845E-03	27500.	0.8356E-04	150000.	0.1542E 05
5500.	0.2223E-03	30000.	0.7592E-04	175000.	0.1055E 05
6000.	0.1387E-03	40000.	0.1004E-03	200000.	0.8063E 04
8000.	0.1311E-03	50000.	0.1182E-02	300000.	0.2455E 04
10000.	0.1629E-03	60000.	0.1276E-01	400000.	0.9417E 03

(d) Temperature, 10 000° R (5556 K)

PRESSURE	0.1013E 09 N/M2	TOTAL NUMBER DENSITY	0.1321E 28 1/M3
TEMPERATURE	10000. R	H IONIZATION POTENTIAL	109531. 1/CM
TEMPERATURE	5556. K	PLANCK MEAN OPACITY	0.2837E-01 1/CM
DENSITY	0.3765E-02 G/CM3	ROSSELAND MEAN OPACITY	0.2371E-01 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	3.921E 26	H2(EXCITED STATES)	1.249E 18
H(EXCITED STATES)	9.072E 17	H-	7.083E 20
H+	1.302E 20	H2+	1.056E 20
E	1.442E 21	H3+	1.915E 21
H2(GROUND STATE)	9.290E 26		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.4553E 00	11000.	0.3321E-01	70000.	0.4307E-02
1500.	0.2020E 00	12000.	0.3371E-01	75000.	0.3796E-02
2000.	0.1134E 00	13500.	0.3304E-01	80000.	0.3377E-02
2500.	0.7237E-01	15000.	0.3140E-01	90000.	0.2777E-02
3000.	0.5011E-01	20000.	0.2463E-01	100000.	0.2320E-02
4000.	0.2801E-01	25000.	0.1957E-01	125000.	0.6801E 04
5000.	0.1782E-01	27500.	0.1769E-01	150000.	0.8851E 04
5500.	0.1468E-01	30000.	0.1635E-01	175000.	0.6029E 04
6000.	0.1230E-01	40000.	0.2100E-01	200000.	0.4563E 04
8000.	0.2361E-01	50000.	0.1102E 00	300000.	0.1397E 04
10000.	0.3160E-01	60000.	0.5737E 00	400000.	0.5441E 03

[a]Wave numbers in table are photon wave numbers.

TABLE VII. - Continued. ABSORPTION COEFFICIENTS AND OPACITY OF HYDROGEN AT 1000 ATMOSPHERES (10.13×10^7 N/m^2) PRESSURE[a]

(e) Temperature, 13 000° R (7222 K)

PRESSURE	0.1013E 09 N/M2	TOTAL NUMBER DENSITY	0.1016E 28 1/M3
TEMPERATURE	13000. R	H IONIZATION POTENTIAL	109167. 1/CM
TEMPERATURE	7222. K	PLANCK MEAN OPACITY	0.3766E 00 1/CM
DENSITY	0.2280E-02 G/CM3	ROSSELAND MEAN OPACITY	0.3011E 00 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	6.699E 26	H2(EXCITED STATES)	1.382E 20
H(EXCITED STATES)	2.249E 20	H-	9.383E 21
H+	1.481E 22	H2+	6.815E 21
E	2.404E 22	H3+	1.179E 22
H2(GROUND STATE)	3.463E 26		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.8016E 01	11000.	0.4468E 00	70000.	0.6859E-01
1500.	0.3565E 01	12000.	0.4536E 00	75000.	0.6200E-01
2000.	0.2008E 01	13500.	0.4458E 00	80000.	0.5664E-01
2500.	0.1288E 01	15000.	0.4259E 00	90000.	0.4901E-01
3000.	0.8969E 00	20000.	0.3407E 00	100000.	0.4323E-01
4000.	0.5083E 00	25000.	0.2759E 00	125000.	0.4824E 04
5000.	0.3287E 00	27500.	0.2467E 00	150000.	0.4697E 04
5500.	0.2734E 00	30000.	0.2285E 00	175000.	0.3163E 04
6000.	0.2314E 00	40000.	0.2395E 00	200000.	0.2334E 04
8000.	0.3373E 00	50000.	0.6675E 00	300000.	0.7248E 03
10000.	0.4274E 00	60000.	0.2157E 01	400000.	0.2934E 03

(f) Temperature, 16 000° R (8889 K)

PRESSURE	0.1013E 09 N/M2	TOTAL NUMBER DENSITY	0.8257E 27 1/M3
TEMPERATURE	16000. R	H IONIZATION POTENTIAL	108447. 1/CM
TEMPERATURE	8889. K	PLANCK MEAN OPACITY	0.1927E 01 1/CM
DENSITY	0.1571E-02 G/CM3	ROSSELAND MEAN OPACITY	0.1313E 01 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	7.121E 26	H2(EXCITED STATES)	1.605E 21
H(EXCITED STATES)	5.621E 21	H-	4.625E 22
H+	1.785E 23	H2+	4.408E 22
E	1.920E 23	H3+	1.571E 22
H2(GROUND STATE)	1.131E 26		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.5920E 02	11000.	0.2330E 01	70000.	0.3661E 00
1500.	0.2634E 02	12000.	0.2339E 01	75000.	0.3320E 00
2000.	0.1485E 02	13500.	0.2285E 01	80000.	0.3042E 00
2500.	0.9536E 01	15000.	0.2180E 01	90000.	0.2644E 00
3000.	0.6650E 01	20000.	0.1758E 01	100000.	0.2343E 00
4000.	0.3785E 01	25000.	0.1431E 01	125000.	0.3732E 04
5000.	0.2462E 01	27500.	0.1298E 01	150000.	0.2851E 04
5500.	0.2054E 01	30000.	0.1185E 01	175000.	0.1897E 04
6000.	0.1745E 01	40000.	0.9842E 00	200000.	0.1360E 04
8000.	0.1942E 01	50000.	0.1487E 01	300000.	0.4291E 03
10000.	0.2245E 01	60000.	0.3067E 01	400000.	0.1812E 03

[a]Wave numbers in table are photon wave numbers.

TABLE VII. - Continued. ABSORPTION COEFFICIENTS AND OPACITY OF HYDROGEN AT 1000 ATMOSPHERES (10.13×10^7 N/m^2) PRESSURE[a]

(g) Temperature, 20 000° R (11 111 K)

PRESSURE	0.1013E 09 N/M2	TOTAL NUMBER DENSITY	0.6607E 27 1/M3
TEMPERATURE	20000. R	H IONIZATION POTENTIAL	106936. 1/CM
TEMPERATURE	11111. K	PLANCK MEAN OPACITY	0.8026E 01 1/CM
DENSITY	0.1156E-02 G/CM3	ROSSELAND MEAN OPACITY	0.3176E 01 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	6.267E 26	H2(EXCITED STATES)	9.695E 21
H(EXCITED STATES)	8.068E 22	H-	1.628E 23
H+	1.307E 24	H2+	1.543E 23
E	1.313E 24	H3+	1.407E 22
H2(GROUND STATE)	3.097E 25		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.3584E 03	11000.	0.9335E 01	70000.	0.1361E 01
1500.	0.1587E 03	12000.	0.9136E 01	75000.	0.1227E 01
2000.	0.8916E 02	13500.	0.8721E 01	80000.	0.1117E 01
2500.	0.5710E 02	15000.	0.8220E 01	90000.	0.9594E 00
3000.	0.3973E 02	20000.	0.6534E 01	100000.	0.8406E 00
4000.	0.2251E 02	25000.	0.6250E 01	125000.	0.2909E 04
5000.	0.1466E 02	27500.	0.5241E 01	150000.	0.1933E 04
5500.	0.1220E 02	30000.	0.4660E 01	175000.	0.1275E 04
6000.	0.1033E 02	40000.	0.3097E 01	200000.	0.8947E 03
8000.	0.8886E 01	50000.	0.2254E 01	300000.	0.2858E 03
10000.	0.9469E 01	60000.	0.1723E 01	400000.	0.1243E 03

(h) Temperature, 23 000° R (12 778 K)

PRESSURE	0.1013E 09 N/M2	TOTAL NUMBER DENSITY	0.5750E 27 1/M3
TEMPERATURE	23000. R	H IONIZATION POTENTIAL	105499. 1/CM
TEMPERATURE	12778. K	PLANCK MEAN OPACITY	0.1791E 02 1/CM
DENSITY	0.9803E-03 G/CM3	ROSSELAND MEAN OPACITY	0.5204E 01 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	5.527E 26	H2(EXCITED STATES)	2.228E 22
H(EXCITED STATES)	3.162E 23	H-	2.915E 23
H+	3.658E 24	H2+	2.719E 23
E	3.651E 24	H3+	1.266E 22
H2(GROUND STATE)	1.413E 25		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.1160E 04	11000.	0.1846E 02	70000.	0.2593E 01
1500.	0.4314E 03	12000.	0.1752E 02	75000.	0.2325E 01
2000.	0.2399E 03	13500.	0.1619E 02	80000.	0.2107E 01
2500.	0.1524E 03	15000.	0.1491E 02	90000.	0.1792E 01
3000.	0.1070E 03	20000.	0.1131E 02	100000.	0.1557E 01
4000.	0.5970E 02	25000.	0.1225E 02	125000.	0.2493E 04
5000.	0.3793E 02	27500.	0.1106E 02	150000.	0.1594E 04
5500.	0.3125E 02	30000.	0.9701E 01	175000.	0.1048E 04
6000.	0.2618E 02	40000.	0.6217E 01	200000.	0.7310E 03
8000.	0.1925E 02	50000.	0.4419E 01	300000.	0.2344E 03
10000.	0.1950E 02	60000.	0.3322E 01	400000.	0.1028E 03

[a]Wave numbers in table are photon wave numbers.

TABLE VII. - Continued. ABSORPTION COEFFICIENTS AND OPACITY OF HYDROGEN AT 1000 ATMOSPHERES (10.13×10^7 N/m^2) PRESSURE[a]

(i) Temperature, 26 000° R (14 444 K)

PRESSURE	0.1013E 09 N/M2	TOTAL NUMBER DENSITY	0.5097E 27 1/M3
TEMPERATURE	26000. R	H IONIZATION POTENTIAL	103913. 1/CM
TEMPERATURE	14444. K	PLANCK MEAN OPACITY	0.3539E 02 1/CM
DENSITY	0.8524E-03 G/CM3	ROSSELAND MEAN OPACITY	0.7521E 01 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	4.846E 26	H2(EXCITED STATES)	3.965E 22
H(EXCITED STATES)	8.944E 23	H-	4.323E 23
H+	8.067E 24	H2+	3.997E 23
E	8.046E 24	H3+	1.133E 22
H2(GROUND STATE)	7.209E 24		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.3619E 04	11000.	0.3436E 02	70000.	0.4183E 01
1500.	0.1193E 04	12000.	0.3159E 02	75000.	0.3729E 01
2000.	0.5741E 03	13500.	0.2817E 02	80000.	0.3362E 01
2500.	0.3606E 03	15000.	0.2530E 02	90000.	0.2831E 01
3000.	0.2473E 03	20000.	0.1835E 02	100000.	0.2439E 01
4000.	0.1366E 03	25000.	0.2254E 02	125000.	0.2158E 04
5000.	0.8618E 02	27500.	0.1996E 02	150000.	0.1354E 04
5500.	0.7076E 02	30000.	0.1727E 02	175000.	0.8895E 03
6000.	0.5910E 02	40000.	0.1063E 02	200000.	0.6183E 03
8000.	0.4878E 02	50000.	0.7356E 01	300000.	0.1986E 03
10000.	0.3778E 02	60000.	0.5430E 01	400000.	0.8754E 02

(j) Temperature, 30 000° R (16 667 K)

PRESSURE	0.1013E 09 N/M2	TOTAL NUMBER DENSITY	0.4446E 27 1/M3
TEMPERATURE	30000. R	H IONIZATION POTENTIAL	101762. 1/CM
TEMPERATURE	16667. K	PLANCK MEAN OPACITY	0.6788E 02 1/CM
DENSITY	0.7205E-03 G/CM3	ROSSELAND MEAN OPACITY	0.8660E 01 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	4.020E 26	H2(EXCITED STATES)	5.193E 22
H(EXCITED STATES)	2.396E 24	H-	5.911E 23
H+	1.789E 25	H2+	5.443E 23
E	1.785E 25	H3+	9.245E 21
H2(GROUND STATE)	3.243E 24		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.1131E 05	11000.	0.6907E 02	70000.	0.5409E 01
1500.	0.4179E 04	12000.	0.6110E 02	75000.	0.4652E 01
2000.	0.1758E 04	13500.	0.5195E 02	80000.	0.4041E 01
2500.	0.1008E 04	15000.	0.4497E 02	90000.	0.3162E 01
3000.	0.6326E 03	20000.	0.6507E 02	100000.	0.2525E 01
4000.	0.3414E 03	25000.	0.4243E 02	125000.	0.1775E 04
5000.	0.2820E 03	27500.	0.3534E 02	150000.	0.1100E 04
5500.	0.2314E 03	30000.	0.2988E 02	175000.	0.7222E 03
6000.	0.1930E 03	40000.	0.1698E 02	200000.	0.5009E 03
8000.	0.1132E 03	50000.	0.1093E 02	300000.	0.1611E 03
10000.	0.7938E 02	60000.	0.7531E 01	400000.	0.7124E 02

[a]Wave numbers in table are photon wave numbers.

TABLE VII. - Continued. ABSORPTION COEFFICIENTS AND OPACITY OF HYDROGEN AT 1000 ATMOSPHERES (10.13×10^7 N/m^2) PRESSURE[a]

(k) Temperature, 40 000° R (22 222 K)

PRESSURE	0.1013E 09 N/M2	TOTAL NUMBER DENSITY	0.3452E 27 1/M3
TEMPERATURE	40000. R	H IONIZATION POTENTIAL	97588. 1/CM
TEMPERATURE	22222. K	PLANCK MEAN OPACITY	0.2110E 03 1/CM
DENSITY	0.4846E-03 G/CM3	ROSSELAND MEAN OPACITY	0.1617E 02 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	2.238E 26	H2(EXCITED STATES)	5.215E 22
H(EXCITED STATES)	6.245E 24	H-	5.941E 23
H+	5.680E 25	H2+	5.504E 23
E	5.676E 25	H3+	3.191E 21
H2(GROUND STATE)	4.853E 23		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.2746E 05	11000.	0.1926E 03	70000.	0.9476E 01
1500.	0.2262E 05	12000.	0.1618E 03	75000.	0.8022E 01
2000.	0.1568E 05	13500.	0.1282E 03	80000.	0.6867E 01
2500.	0.7520E 04	15000.	0.1042E 03	90000.	0.5209E 01
3000.	0.3934E 04	20000.	0.1609E 03	100000.	0.1770E 04
4000.	0.1798E 04	25000.	0.9948E 02	125000.	0.9816E 03
5000.	0.1039E 04	27500.	0.8076E 02	150000.	0.6019E 03
5500.	0.8377E 03	30000.	0.6664E 02	175000.	0.3948E 03
6000.	0.6897E 03	40000.	0.3487E 02	200000.	0.2733E 03
8000.	0.3709E 03	50000.	0.2094E 02	300000.	0.8803E 02
10000.	0.2336E 03	60000.	0.1370E 02	400000.	0.3904E 02

(ℓ) Temperature, 50 000° R (27 778 K)

PRESSURE	0.1013E 09 N/M2	TOTAL NUMBER DENSITY	0.2845E 27 1/M3
TEMPERATURE	50000. R	H IONIZATION POTENTIAL	96296. 1/CM
TEMPERATURE	27778. K	PLANCK MEAN OPACITY	0.1695E 03 1/CM
DENSITY	0.3302E-03 G/CM3	ROSSELAND MEAN OPACITY	0.1779E 02 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	1.006E 26	H2(EXCITED STATES)	1.968E 22
H(EXCITED STATES)	8.129E 24	H-	2.722E 23
H+	8.758E 25	H2+	2.550E 23
E	8.756E 25	H3+	4.303E 20
H2(GROUND STATE)	6.039E 22		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.3495E 05	11000.	0.2697E 03	70000.	0.9413E 01
1500.	0.3073E 05	12000.	0.2227E 03	75000.	0.7869E 01
2000.	0.2529E 05	13500.	0.1719E 03	80000.	0.6653E 01
2500.	0.1778E 05	15000.	0.3507E 03	90000.	0.4910E 01
3000.	0.8749E 04	20000.	0.1894E 03	100000.	0.7949E 03
4000.	0.3004E 04	25000.	0.1152E 03	125000.	0.4411E 03
5000.	0.1652E 04	27500.	0.9268E 02	150000.	0.2699E 03
5500.	0.1307E 04	30000.	0.7578E 02	175000.	0.1771E 03
6000.	0.1053E 04	40000.	0.3823E 02	200000.	0.1225E 03
8000.	0.5462E 03	50000.	0.2212E 02	300000.	0.3947E 02
10000.	0.3327E 03	60000.	0.1399E 02	400000.	0.1752E 02

[a]Wave numbers in table are photon wave numbers.

TABLE VII. - Continued. ABSORPTION COEFFICIENTS AND OPACITY OF HYDROGEN AT 1000 ATMOSPHERES (10.13×10^7 N/m^2) PRESSURE[a]

(m) Temperature, 60 000° R (33 333 K)

PRESSURE	0.1013E 09 N/M2	TOTAL NUMBER DENSITY	0.2376E 27 1/M3
TEMPERATURE	60000. R	H IONIZATION POTENTIAL	96972. 1/CM
TEMPERATURE	33333. K	PLANCK MEAN OPACITY	0.9079E 02 1/CM
DENSITY	0.2388E-03 G/CM3	ROSSELAND MEAN OPACITY	0.1517E 02 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	4.035E 25	H2(EXCITED STATES)	4.844E 21
H(EXCITED STATES)	7.150E 24	H-	8.530E 22
H+	9.494E 25	H2+	8.078E 22
E	9.494E 25	H3+	3.686E 19
H2(GROUND STATE)	6.744E 21		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.3570E 05	11000.	0.2348E 03	70000.	0.7010E 01
1500.	0.3188E 05	12000.	0.1934E 03	75000.	0.5830E 01
2000.	0.2675E 05	13500.	0.1485E 03	80000.	0.4901E 01
2500.	0.1950E 05	15000.	0.2715E 03	90000.	0.3568E 01
3000.	0.9288E 04	20000.	0.1467E 03	100000.	0.3174E 03
4000.	0.2701E 04	25000.	0.8914E 02	125000.	0.1769E 03
5000.	0.1458E 04	27500.	0.7166E 02	150000.	0.1083E 03
5500.	0.1150E 04	30000.	0.5854E 02	175000.	0.7111E 02
6000.	0.9288E 03	40000.	0.2936E 02	200000.	0.4920E 02
8000.	0.4792E 03	50000.	0.1682E 02	300000.	0.1585E 02
10000.	0.2905E 03	60000.	0.1052E 02	400000.	0.7037E 01

(n) Temperature, 70 000° R (38 889 K)

PRESSURE	0.1013E 09 N/M2	TOTAL NUMBER DENSITY	0.2014E 27 1/M3
TEMPERATURE	70000. R	H IONIZATION POTENTIAL	98255. 1/CM
TEMPERATURE	38889. K	PLANCK MEAN OPACITY	0.4259E 02 1/CM
DENSITY	0.1871E-03 G/CM3	ROSSELAND MEAN OPACITY	0.1079E 02 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	1.644E 25	H2(EXCITED STATES)	1.145E 21
H(EXCITED STATES)	5.716E 24	H-	2.504E 22
H+	8.957E 25	H2+	2.392E 22
E	8.957E 25	H3+	3.253E 18
H2(GROUND STATE)	8.365E 20		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.3393E 05	11000.	0.1712E 03	70000.	0.4729E 01
1500.	0.3031E 05	12000.	0.1412E 03	75000.	0.3931E 01
2000.	0.2508E 05	13500.	0.1087E 03	80000.	0.3302E 01
2500.	0.1715E 05	15000.	0.8584E 02	90000.	0.2396E 01
3000.	0.6169E 04	20000.	0.9718E 02	100000.	0.1285E 03
4000.	0.1874E 04	25000.	0.5932E 02	125000.	0.7206E 02
5000.	0.1033E 04	27500.	0.4778E 02	150000.	0.4425E 02
5500.	0.8195E 03	30000.	0.3910E 02	175000.	0.2907E 02
6000.	0.6662E 03	40000.	0.1972E 02	200000.	0.2012E 02
8000.	0.3470E 03	50000.	0.1134E 02	300000.	0.6485E 01
10000.	0.2115E 03	60000.	0.7100E 01	400000.	0.2878E 01

[a]Wave numbers in table are photon wave numbers.

TABLE VII. - Concluded. ABSORPTION COEFFICIENTS AND OPACITY OF HYDROGEN AT 1000 ATMOSPHERES (10.13×10^7 N/m^2) PRESSURE[a]

(o) Temperature, 80 000° R (44 444 K)

PRESSURE	0.1013E 09 N/M2	TOTAL NUMBER DENSITY	0.1740E 27 1/M3
TEMPERATURE	80000. R	H IONIZATION POTENTIAL	99510. 1/CM
TEMPERATURE	44444. K	PLANCK MEAN OPACITY	0.2023E 02 1/CM
DENSITY	0.1555E-03 G/CM3	ROSSELAND MEAN OPACITY	0.6495E 01 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	7.296E 24	H2(EXCITED STATES)	2.994E 20
H(EXCITED STATES)	4.492E 24	H-	8.003E 21
H+	8.112E 25	H2+	7.705E 21
E	8.112E 25	H3+	3.587E 17
H2(GROUND STATE)	1.293E 20		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.3120E 05	11000.	0.1201E 03	70000.	0.3169E 01
1500.	0.2756E 05	12000.	0.9925E 02	75000.	0.2639E 01
2000.	0.2212E 05	13500.	0.7661E 02	80000.	0.2219E 01
2500.	0.1327E 05	15000.	0.6069E 02	90000.	0.1613E 01
3000.	0.3482E 04	20000.	0.6289E 02	100000.	0.5662E 02
4000.	0.1234E 04	25000.	0.3858E 02	125000.	0.3196E 02
5000.	0.6994E 03	27500.	0.3115E 02	150000.	0.1969E 02
5500.	0.5581E 03	30000.	0.2555E 02	175000.	0.1296E 02
6000.	0.4571E 03	40000.	0.1300E 02	200000.	0.8979E 01
8000.	0.2410E 03	50000.	0.7524E 01	300000.	0.2895E 01
10000.	0.1479E 03	60000.	0.4738E 01	400000.	0.1284E 01

(p) Temperature, 90 000° R (50 000 K)

PRESSURE	0.1013E 09 N/M2	TOTAL NUMBER DENSITY	0.1532E 27 1/M3
TEMPERATURE	90000. R	H IONIZATION POTENTIAL	100583. 1/CM
TEMPERATURE	50000. K	PLANCK MEAN OPACITY	0.8371E 01 1/CM
DENSITY	0.1341E-03 G/CM3	ROSSELAND MEAN OPACITY	0.2898E 01 1/CM

SPECIES	NO. DENSITY (1/M3)	SPECIES	NO. DENSITY (1/M3)
H(GROUND STATE)	3.573E 24	H2(EXCITED STATES)	9.247E 19
H(EXCITED STATES)	3.521E 24	H-	2.892E 21
H+	7.303E 25	H2+	2.802E 21
E	7.303E 25	H3+	5.117E 16
H2(GROUND STATE)	2.518E 19		

WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)	WAVE NUMBER (1/CM)	ABSORPTION COEFFICIENT (1/CM)
1000.	0.2924E 05	11000.	0.8344E 02	70000.	0.2154E 01
1500.	0.2548E 05	12000.	0.6910E 02	75000.	0.1797E 01
2000.	0.1952E 05	13500.	0.5348E 02	80000.	0.1515E 01
2500.	0.8283E 04	15000.	0.4246E 02	90000.	0.1104E 01
3000.	0.1903E 04	20000.	0.4120E 02	100000.	0.8285E 00
4000.	0.8185E 03	25000.	0.2539E 02	125000.	0.1563E 02
5000.	0.4735E 03	27500.	0.2055E 02	150000.	0.9670E 01
5500.	0.3800E 03	30000.	0.1689E 02	175000.	0.6379E 01
6000.	0.3124E 03	40000.	0.8670E 01	200000.	0.4424E 01
8000.	0.1662E 03	50000.	0.5055E 01	300000.	0.1428E 01
10000.	0.1025E 03	60000.	0.3203E 01	400000.	0.6334E 00

[a]Wave numbers in table are photon wave numbers.

TABLE VIII. - MAXIMUM PERCENT CONTRIBUTIONS OF VARIOUS TRANSITIONS TO THE SPECTRAL ABSORPTION COEFFICIENTS FROM 500 TO 400 000 PHOTON WAVE NUMBERS FOR TEMPERATURES OF 1667 TO 50 000 K AND PRESSURES OF 1.013×10^{7} TO 1.013×10^{8} N/m^2

Transition	Conditions at which maximum contribution occurred			Maximum percent contribution
	Temperature, K	Pressure, N/m^2	Photon wave number, cm^{-1}	
H photoionization	27 778	0.1013×10^{8}	110 000	100
H, H_2, and H_3 inverse bremsstrahlung collectively	50 000	.1013	500	100
H^- inverse bremsstrahlung	7 222	.1013	500	96
H^- photodetachment	3 889	.1013	65 000	99
H_2 photodissociation and photoionization collectively	1 667	1.013	125 000	100
H-H quasimolecular	1 667	1.013	60 000	100
H_2-H_2 pressure-induced translational	2 778	1.013	500	36
H_2-H_2 pressure-induced rotational	3 001	1.013	2 250	100
H_2-H_2 pressure-induced vibrational	1 667	1.013	10 000	100
H_2^- inverse bremsstrahlung	3 889	1.013	500	82
H_2^+ photodissociation and inverse bremsstrahlung collectively	7 222	0.1013	100 000	47

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