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# CORNELL AERONAUTICAL LABORATORY, INC.

Report No. BE-1007-A-5

**THERMODYNAMIC PROPERTIES OF NITROGEN  
FROM 2000°K TO 8000°K**

BY  
*C. E. Treanor and J. O. Logan, Jr.*

JANUARY 1957

General Electric Company Subcontract No. SDP-1001

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B U F F A L O , N E W Y O R K

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F.K. Moore, Head  
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ABSTRACT

~~This report presents~~ <sup>↓</sup> tables of thermodynamic properties of nitrogen at high temperatures, including effects of dissociation and ionisation. The partition functions, first and second temperature derivatives of partition functions, equilibrium constants and temperature derivatives of equilibrium constants are tabulated at intervals of 500°K between 2000°K and 8000°K. The mole fraction composition, temperature and density derivatives of mole fraction composition, pressure, entropy, enthalpy, specific heats and speed of sound are tabulated at the temperatures given above and at densities of <sup>1/1000</sup>10<sup>-3</sup>, <sup>1/100</sup>10<sup>-2</sup>, <sup>1/10</sup>10<sup>-1</sup>, 1 and 10 times standard atmospheric density. All quantities were calculated directly from the formulas of statistical mechanics, using digital computers and employing the most recent spectroscopic data. Effects of the second virial coefficient are not included. <sup>↖</sup>

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## LIST OF SYMBOLS

|                   |   |
|-------------------|---|
| $a$               | Speed of sound  |
| $c_p$             | Specific heat at constant pressure  |
| $c_v$             | Specific heat at constant volume  |
| $f_1$             | Partition function, including translation, dissociation and ionization for species 1            |
| $H$               | Enthalpy  |
| $K_1, K_2, K_3$   | Equilibrium constants (see "Contents of Tables", Table IV)                                      |
| $M$               | Molecular weight of gas   |
| $M_1$             | Molecular weight of $i^{\text{th}}$ species   |
| $[N_2], [N]$ etc. | Number of moles of $N_2$ , $N$ , etc. originating from one mole of $N_2$ at standard conditions |
| $P$               | Pressure  |
| $Q_1$             | Internal partition functions for species 1  |
| $S$               | Entropy   |
| $T$               | Temperature ( $^{\circ}\text{K}$ )  |
| $X_1$             | Mole fraction of species 1, i.e., number of moles of species 1 per mole of gas                  |
| $Z$               | Total number of moles of gas originating from one mole of $N_2$ at standard conditions          |
| $\gamma$          | Specific heat ratio   |
| $\rho$            | Density   |

Subscript zero refers to NACA standard conditions (see page 2)

## INTRODUCTION

In the course of calculating the thermodynamic properties of air at high temperatures<sup>1</sup>, the partition functions for the atomic and molecular constituents of air were calculated from spectroscopic data and were available on punched cards. A relatively easy program could then be prepared for the IBM card programmed calculator to obtain the thermodynamic properties of pure oxygen and pure nitrogen. Tables of these properties are of value in various aerodynamic calculations, and are not available at present in a form that includes the effects of dissociation and ionization. Accordingly, the calculations were performed for oxygen over the temperature range from 2000°K to 5000°K at 100° intervals and for 15 densities between  $10^{-3}$  and about 15 times standard atmospheric density<sup>2</sup>. The present report is the result of a similar calculation for nitrogen covering the temperature range from 2000°K to 8000°K at 500° intervals and for five densities from  $10^{-3}$  to 10 times atmospheric density.

## NUMERICAL CALCULATIONS

The thermodynamic properties of nitrogen that are tabulated herein were calculated from spectroscopic data as given in Herzberg<sup>3</sup> and Moore<sup>4</sup>, with the exception that the dissociation energy of  $N_2$  was taken as 9.756 e.v. instead of the value given in Herzberg. The formulas and calculation procedures that were used are exactly parallel to those used for oxygen in Ref. 2, and so are not repeated here. All calculations were performed on the IBM card-programmed calculator at Cornell Aeronautical Laboratory. Reference conditions (subscript zero) were taken at the pressure and

temperature of NACA standard reference conditions in order to make the tables most useful for aerodynamic calculations. These conditions are

$$P_0 = 1.013 \times 10^6 \frac{\text{dynes}}{\text{cm}^2} = 14.7 \frac{\text{lbs.}}{\text{in.}^2} \quad T_0 = 288.10^\circ\text{K} = 518.6^\circ\text{R}$$

Thus, with the molecular weight of  $N_2 = 28.014$  and  $\gamma_0 = 1.4$ ,

$$\rho_0 = 1.1845 \times 10^{-3} \frac{\text{gms}}{\text{cm}^3} = 2.2963 \times 10^{-4} \frac{\text{slug}}{\text{ft}^3}$$

$$a_0 = 3.460 \times 10^4 \frac{\text{cm}}{\text{sec.}} = 1135 \frac{\text{ft.}}{\text{sec.}}$$

It should be pointed out that these reference conditions are different from those used by Woolley<sup>5</sup> in his calculations for undissociated nitrogen. Also the present calculations do not include the real gas effects of the higher virial coefficients, which are included in Woolley's work.

#### LIST AND DESCRIPTION OF TABLES

The temperature range covered in the tables is  $2000^\circ\text{K}$  to  $8000^\circ\text{K}$  at intervals of  $500^\circ\text{K}$ . The functions which are density dependent were calculated at density values of  $\rho/\rho_0 = 10^{-3}, 10^{-2}, 10^{-1}, 1$  and  $10$ . Tables I through IX contain functions which are not density dependent. These are:

Table I Internal partition functions  $Q_i$

Table II Temperature derivatives of partition functions,  $\frac{dQ_i}{dT}$

Table III Second temperature derivatives of partition functions,  $\frac{d^2Q_i}{dT^2}$

Table IV  $\frac{\rho}{\rho_0}$  times the equilibrium constants

$$K_1 = \frac{[N]^2}{[N_2]} \quad K_2 = \frac{[N_2^+][e^-]}{[N_2]} \quad K_3 = \frac{[N^+][e^-]}{[N]}$$

|            |   |
|------------|---|
| Table V    | Temperature derivatives of the $\ln$ of the equilibrium constant from Table IV              |
| Table VI   | $P/P_0$ times the partition functions including translation, dissociation and ionization    |
| Table VII  | $\ln$ of partition functions from Table VI  |
| Table VIII | Temperature derivatives of $\ln$ of the partition functions from Table VI                   |
| Table IX   | Temperature derivatives of the product of $T^2$ and temperature derivatives from Table VIII |

The remaining tables list functions which are density dependent:

|            |   |
|------------|---|
| Table X    | Mole fractions, the fractional number of particles of each species at a given temperature and density   |
| Table XI   | Temperature derivatives of mole fractions from Table X (density const.)   |
| Table XII  | Density derivatives of mole fractions from Table X (temp. const.)   |
| Table XIII | Entropy in non-dimensional form and in cal/gm <sup>0</sup> K;<br>enthalpy in non-dimensional form and in cal/gm;<br>compressibility factor Z, equal to the ratio of the molecular weight at standard conditions to the molecular weight |
| Table XIV  | Pressure $P/P_0$ ; density derivatives of $P/P_0$ at constant temperature; gram molecular weight; and derivatives of the molecular weight with respect to temperature and density.  |
| Table XV   | Specific heat at constant volume; specific heat at constant pressure; specific heat ratio $\gamma = c_p/c_v$ ; and speed of sound $a/a_0$ .   |

## REFERENCES

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5. Woolley, H.W. Thermodynamic Properties of Gaseous Nitrogen NACA TN 3271 (March 1956)

## ACKNOWLEDGEMENTS

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| T°K  | $Q_{N_2}$     | $Q_N$         | $Q_{N_2^+}$   | $Q_{N^+}$     |
|------|---------------|---------------|---------------|---------------|
| 2000 | 8.57628X10*02 | 4.00000X10*00 | 1.84392X10*03 | 8.44543X10*00 |
| 2500 | 1.18249X10*03 | 4.00015X10*00 | 2.58307X10*03 | 8.55336X10*00 |
| 3000 | 1.56062X10*03 | 4.00099X10*00 | 3.48782X10*03 | 8.62835X10*00 |
| 3500 | 1.99280X10*03 | 4.00374X10*00 | 4.59028X10*03 | 8.68664X10*00 |
| 4000 | 2.47969X10*03 | 4.01012X10*00 | 5.92312X10*03 | 8.73718X10*00 |
| 4500 | 3.02183X10*03 | 4.02202X10*00 | 7.51740X10*03 | 8.78519X10*00 |
| 5000 | 3.61975X10*03 | 4.04111X10*00 | 9.40179X10*03 | 8.83367X10*00 |
| 5500 | 4.27399X10*03 | 4.06867X10*00 | 1.16024X10*04 | 8.88422X10*00 |
| 6000 | 4.98513X10*03 | 4.10555X10*00 | 1.41430X10*04 | 8.93756X10*00 |
| 6500 | 5.75386X10*03 | 4.15212X10*00 | 1.70456X10*04 | 8.99391X10*00 |
| 7000 | 6.58108X10*03 | 4.20840X10*00 | 2.03301X10*04 | 9.05315X10*00 |
| 7500 | 7.46802X10*03 | 4.27413X10*00 | 2.40153X10*04 | 9.11503X10*00 |
| 8000 | 8.41640X10*03 | 4.34884X10*00 | 2.81188X10*04 | 9.17923X10*00 |

Table I  
Internal partition functions

| T°K  | $\frac{dQ_{N_2}}{dT}$ | $\frac{dQ_N}{dT}$ | $\frac{dQ_{N_2^+}}{dT}$ | $\frac{dQ_{N^+}}{dT}$ |
|------|-----------------------|-------------------|-------------------------|-----------------------|
| 2000 | 5.97216X10*01         | 6.83546X10*08     | 1.33239X10*00           | 2.66394X10*04         |
| 2500 | 7.02669X10*01         | 6.96904X10*07     | 1.63362X10*00           | 1.75680X10*04         |
| 3000 | 8.10084X10*01         | 3.07505X10*06     | 1.99621X10*00           | 1.29435X10*04         |
| 3500 | 9.18882X10*01         | 8.50111X10*06     | 2.42458X10*00           | 1.06599X10*04         |
| 4000 | 1.02884X10*00         | 1.76660X10*05     | 2.91714X10*00           | 9.72546X10*05         |
| 4500 | 1.13988X10*00         | 3.04816X10*05     | 3.46955X10*00           | 9.57709X10*05         |
| 5000 | 1.25198X10*00         | 4.63053X10*05     | 4.07670X10*00           | 9.86669X10*05         |
| 5500 | 1.36517X10*00         | 6.42430X10*05     | 4.73370X10*00           | 1.03753X10*04         |
| 6000 | 1.47961X10*00         | 8.33773X10*05     | 5.43623X10*00           | 1.09682X10*04         |
| 6500 | 1.59560X10*00         | 1.02895X10*04     | 6.18062X10*00           | 1.15653X10*04         |
| 7000 | 1.71367X10*00         | 1.22142X10*04     | 6.96375X10*00           | 1.21228X10*04         |
| 7500 | 1.83463X10*00         | 1.40628X10*04     | 7.78302X10*00           | 1.26189X10*04         |
| 8000 | 1.95966X10*00         | 1.58013X10*04     | 8.63626X10*00           | 1.30460X10*04         |

Table II  
Temperature derivatives of partition functions

| T °K | $\frac{d^2 Q_M}{dT^2}$    | $\frac{d^2 Q_M}{dT^2}$    | $\frac{d^2 Q_M}{dT^2}$    |
|------|---------------------------|---------------------------|---------------------------|
| 2000 | 2.08136X10 <sup>-04</sup> | 4.04453X10 <sup>-10</sup> | 5.48202X10 <sup>-04</sup> |
| 2500 | 2.13166X10 <sup>-04</sup> | 2.53168X10 <sup>-09</sup> | 6.61011X10 <sup>-04</sup> |
| 3000 | 2.16320X10 <sup>-04</sup> | 7.44109X10 <sup>-09</sup> | 7.90735X10 <sup>-04</sup> |
| 3500 | 2.18805X10 <sup>-04</sup> | 1.44976X10 <sup>-08</sup> | 9.22094X10 <sup>-04</sup> |
| 4000 | 2.21020X10 <sup>-04</sup> | 2.21235X10 <sup>-08</sup> | 1.04663X10 <sup>-03</sup> |
| 4500 | 2.23132X10 <sup>-04</sup> | 2.89141X10 <sup>-08</sup> | 1.16125X10 <sup>-03</sup> |
| 5000 | 2.25260X10 <sup>-04</sup> | 3.40749X10 <sup>-08</sup> | 1.26569X10 <sup>-03</sup> |
| 5500 | 2.27563X10 <sup>-04</sup> | 3.73659X10 <sup>-08</sup> | 1.36086X10 <sup>-03</sup> |
| 6000 | 2.30296X10 <sup>-04</sup> | 3.88986X10 <sup>-08</sup> | 1.44804X10 <sup>-03</sup> |
| 6500 | 2.33838X10 <sup>-04</sup> | 3.89553X10 <sup>-08</sup> | 1.52846X10 <sup>-03</sup> |
| 7000 | 2.38706X10 <sup>-04</sup> | 3.78695X10 <sup>-08</sup> | 1.60320X10 <sup>-03</sup> |
| 7500 | 2.45540X10 <sup>-04</sup> | 3.59615X10 <sup>-08</sup> | 1.67318X10 <sup>-03</sup> |
| 8000 | 2.55075X10 <sup>-04</sup> | 3.35094X10 <sup>-08</sup> | 1.73915X10 <sup>-03</sup> |

Table III

Second temperature derivatives of partition functions

| T °K | % K <sub>1</sub>          | % K <sub>2</sub>          | % K <sub>3</sub>          |
|------|---------------------------|---------------------------|---------------------------|
| 2000 | 1.20430X10 <sup>-19</sup> | 2.09937X10 <sup>-38</sup> | 8.40159X10 <sup>-36</sup> |
| 2500 | 1.00389X10 <sup>-14</sup> | 2.09706X10 <sup>-30</sup> | 2.51453X10 <sup>-28</sup> |
| 3000 | 1.89170X10 <sup>-11</sup> | 4.80632X10 <sup>-25</sup> | 2.54928X10 <sup>-23</sup> |
| 3500 | 4.09453X10 <sup>-09</sup> | 3.40518X10 <sup>-21</sup> | 9.94647X10 <sup>-20</sup> |
| 4000 | 2.29626X10 <sup>-07</sup> | 2.73842X10 <sup>-18</sup> | 5.04242X10 <sup>-17</sup> |
| 4500 | 5.24498X10 <sup>-06</sup> | 5.14838X10 <sup>-16</sup> | 6.53504X10 <sup>-15</sup> |
| 5000 | 6.40205X10 <sup>-05</sup> | 3.49041X10 <sup>-14</sup> | 3.25122X10 <sup>-13</sup> |
| 5500 | 4.96370X10 <sup>-04</sup> | 1.12440X10 <sup>-12</sup> | 8.04493X10 <sup>-12</sup> |
| 6000 | 2.74276X10 <sup>-03</sup> | 2.06889X10 <sup>-11</sup> | 1.17698X10 <sup>-10</sup> |
| 6500 | 1.16944X10 <sup>-02</sup> | 2.47017X10 <sup>-10</sup> | 1.14782X10 <sup>-09</sup> |
| 7000 | 4.07127X10 <sup>-02</sup> | 2.09667X10 <sup>-09</sup> | 8.13071X10 <sup>-09</sup> |
| 7500 | 1.20595X10 <sup>-01</sup> | 1.35292X10 <sup>-08</sup> | 4.45596X10 <sup>-08</sup> |
| 8000 | 3.13395X10 <sup>-01</sup> | 6.97980X10 <sup>-08</sup> | 1.98126X10 <sup>-07</sup> |

Table IV

times the equilibrium constants

| T°K  | $\frac{1}{K_1} \frac{\partial K_1}{\partial T}$ | $\frac{1}{K_2} \frac{\partial K_2}{\partial T}$ | $\frac{1}{K_3} \frac{\partial K_3}{\partial T}$ |
|------|---|---|---|
| 2000 | 2.83470X10 <sup>-02</sup>                       | 4.59481X10 <sup>-02</sup>                       | 4.29489X10 <sup>-02</sup>                       |
| 2500 | 1.81138X10 <sup>-02</sup>                       | 2.95482X10 <sup>-02</sup>                       | 2.76075X10 <sup>-02</sup>                       |
| 3000 | 1.25572X10 <sup>-02</sup>                       | 2.06256X10 <sup>-02</sup>                       | 1.92553X10 <sup>-02</sup>                       |
| 3500 | 9.21036X10 <sup>-03</sup>                       | 1.52456X10 <sup>-02</sup>                       | 1.42076X10 <sup>-02</sup>                       |
| 4000 | 7.04224X10 <sup>-03</sup>                       | 1.17455X10 <sup>-02</sup>                       | 1.09233X10 <sup>-02</sup>                       |
| 4500 | 5.56008X10 <sup>-03</sup>                       | 9.34050X10 <sup>-03</sup>                       | 8.66602X10 <sup>-03</sup>                       |
| 5000 | 4.50397X10 <sup>-03</sup>                       | 7.61524X10 <sup>-03</sup>                       | 7.04649X10 <sup>-03</sup>                       |
| 5500 | 3.72616X10 <sup>-03</sup>                       | 6.33445X10 <sup>-03</sup>                       | 5.84447X10 <sup>-03</sup>                       |
| 6000 | 3.13751X10 <sup>-03</sup>                       | 5.35667X10 <sup>-03</sup>                       | 4.92723X10 <sup>-03</sup>                       |
| 6500 | 2.68168X10 <sup>-03</sup>                       | 4.59268X10 <sup>-03</sup>                       | 4.21102X10 <sup>-03</sup>                       |
| 7000 | 2.32160X10 <sup>-03</sup>                       | 3.98392X10 <sup>-03</sup>                       | 3.64089X10 <sup>-03</sup>                       |
| 7500 | 2.03211X10 <sup>-03</sup>                       | 3.49064X10 <sup>-03</sup>                       | 3.17951X10 <sup>-03</sup>                       |
| 8000 | 1.79566X10 <sup>-03</sup>                       | 3.08504X10 <sup>-03</sup>                       | 2.80084X10 <sup>-03</sup>                       |

  

| T°K  | % $f_{N_2}$               | % $f_N$                   | % $f_{N_2^+}$             | % $f_{N^+}$               | % $f_{e^-}$               |
|------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|
| 2000 | 2.52884X10 <sup>+34</sup> | 4.30054X10 <sup>+19</sup> | 3.15886X10 <sup>-05</sup> | 2.14745X10 <sup>-17</sup> | 1.02176X10 <sup>+25</sup> |
| 2500 | 4.87291X10 <sup>+34</sup> | 1.72359X10 <sup>+22</sup> | 4.34967X10 <sup>+03</sup> | 1.84317X10 <sup>-07</sup> | 1.42795X10 <sup>+25</sup> |
| 3000 | 8.45390X10 <sup>+34</sup> | 9.85485X10 <sup>+23</sup> | 1.31550X10 <sup>+09</sup> | 8.12773X10 <sup>-01</sup> | 1.87709X10 <sup>+25</sup> |
| 3500 | 1.36033X10 <sup>+35</sup> | 1.83916X10 <sup>+25</sup> | 1.18998X10 <sup>+13</sup> | 4.69647X10 <sup>+04</sup> | 2.36541X10 <sup>+25</sup> |
| 4000 | 2.06807X10 <sup>+35</sup> | 1.69819X10 <sup>+26</sup> | 1.19069X10 <sup>+16</sup> | 1.79937X10 <sup>+08</sup> | 2.88998X10 <sup>+25</sup> |
| 4500 | 3.00723X10 <sup>+35</sup> | 9.78703X10 <sup>+26</sup> | 2.72782X10 <sup>+18</sup> | 1.12632X10 <sup>+11</sup> | 3.44845X10 <sup>+25</sup> |
| 5000 | 4.21903X10 <sup>+35</sup> | 4.05005X10 <sup>+27</sup> | 2.21518X10 <sup>+20</sup> | 1.97987X10 <sup>+13</sup> | 4.03887X10 <sup>+25</sup> |
| 5500 | 5.74720X10 <sup>+35</sup> | 1.31621X10 <sup>+28</sup> | 8.42547X10 <sup>+21</sup> | 1.38003X10 <sup>+15</sup> | 4.65960X10 <sup>+25</sup> |
| 6000 | 7.63805X10 <sup>+35</sup> | 3.56681X10 <sup>+28</sup> | 1.80816X10 <sup>+23</sup> | 4.80184X10 <sup>+16</sup> | 5.30923X10 <sup>+25</sup> |
| 6500 | 9.94050X10 <sup>+35</sup> | 8.40212X10 <sup>+28</sup> | 2.49170X10 <sup>+24</sup> | 9.78318X10 <sup>+17</sup> | 5.98653X10 <sup>+25</sup> |
| 7000 | 1.27064X10 <sup>+36</sup> | 1.77244X10 <sup>+29</sup> | 2.41895X10 <sup>+25</sup> | 1.30808X10 <sup>+19</sup> | 6.69040X10 <sup>+25</sup> |
| 7500 | 1.59910X10 <sup>+36</sup> | 3.42214X10 <sup>+29</sup> | 1.77121X10 <sup>+26</sup> | 1.24805X10 <sup>+20</sup> | 7.41988X10 <sup>+25</sup> |
| 8000 | 1.98536X10 <sup>+36</sup> | 6.14697X10 <sup>+29</sup> | 1.02979X10 <sup>+27</sup> | 9.04801X10 <sup>+20</sup> | 8.17410X10 <sup>+25</sup> |

Table V

Temperature derivatives of  $\ln$  of equilibrium constants

Table VI

$10^0$  times partition functions

| T°K  | $\ln f_{N_2}$             | $\ln f_N$                 | $\ln f_{N_2^+}$            | $\ln f_{N^+}$              | $\ln f_{e^-}$             |
|------|---------------------------|---------------------------|----------------------------|----------------------------|---------------------------|
| 2000 | 7.92156X10 <sup>-01</sup> | 4.52078X10 <sup>-01</sup> | -1.03627X10 <sup>-01</sup> | -3.83796X10 <sup>-01</sup> | 5.75861X10 <sup>-01</sup> |
| 2500 | 7.98715X10 <sup>-01</sup> | 5.12012X10 <sup>-01</sup> | 8.37785X10 <sup>-00</sup>  | -1.55066X10 <sup>-01</sup> | 5.79208X10 <sup>-01</sup> |
| 3000 | 8.04225X10 <sup>-01</sup> | 5.52474X10 <sup>-01</sup> | 2.09974X10 <sup>-01</sup>  | -2.07302X10 <sup>-01</sup> | 5.81943X10 <sup>-01</sup> |
| 3500 | 8.08982X10 <sup>-01</sup> | 5.81739X10 <sup>-01</sup> | 3.01075X10 <sup>-01</sup>  | 1.07571X10 <sup>-01</sup>  | 5.84255X10 <sup>-01</sup> |
| 4000 | 8.13170X10 <sup>-01</sup> | 6.03967X10 <sup>-01</sup> | 3.70159X10 <sup>-01</sup>  | 1.90081X10 <sup>-01</sup>  | 5.86258X10 <sup>-01</sup> |
| 4500 | 8.16915X10 <sup>-01</sup> | 6.21482X10 <sup>-01</sup> | 4.24500X10 <sup>-01</sup>  | 2.54473X10 <sup>-01</sup>  | 5.88025X10 <sup>-01</sup> |
| 5000 | 8.20300X10 <sup>-01</sup> | 6.35685X10 <sup>-01</sup> | 4.68470X10 <sup>-01</sup>  | 3.06166X10 <sup>-01</sup>  | 5.89605X10 <sup>-01</sup> |
| 5500 | 8.23391X10 <sup>-01</sup> | 6.47471X10 <sup>-01</sup> | 5.04855X10 <sup>-01</sup>  | 3.48608X10 <sup>-01</sup>  | 5.91035X10 <sup>-01</sup> |
| 6000 | 8.26236X10 <sup>-01</sup> | 6.57440X10 <sup>-01</sup> | 5.35517X10 <sup>-01</sup>  | 3.84103X10 <sup>-01</sup>  | 5.92340X10 <sup>-01</sup> |
| 6500 | 8.28870X10 <sup>-01</sup> | 6.66008X10 <sup>-01</sup> | 5.61750X10 <sup>-01</sup>  | 4.14246X10 <sup>-01</sup>  | 5.93541X10 <sup>-01</sup> |
| 7000 | 8.31325X10 <sup>-01</sup> | 6.73473X10 <sup>-01</sup> | 5.84479X10 <sup>-01</sup>  | 4.40176X10 <sup>-01</sup>  | 5.94653X10 <sup>-01</sup> |
| 7500 | 8.33625X10 <sup>-01</sup> | 6.80052X10 <sup>-01</sup> | 6.04388X10 <sup>-01</sup>  | 4.62732X10 <sup>-01</sup>  | 5.95687X10 <sup>-01</sup> |
| 8000 | 8.35788X10 <sup>-01</sup> | 6.85909X10 <sup>-01</sup> | 6.21991X10 <sup>-01</sup>  | 4.82542X10 <sup>-01</sup>  | 5.96655X10 <sup>-01</sup> |

Table VII

$\ln$  of partition functions

| T°K  | $\frac{\partial \ln f_{N_2}}{\partial T}$ | $\frac{\partial \ln f_N}{\partial T}$ | $\frac{\partial \ln f_{N_2^+}}{\partial T}$ | $\frac{\partial \ln f_{N^+}}{\partial T}$ | $\frac{\partial \ln f_{e^-}}{\partial T}$ |
|------|---|---------------------------------------|---|---|---|
| 2000 | 1.44635X10 <sup>-03</sup>                 | 1.48966X10 <sup>-02</sup>             | 4.66445X10 <sup>-02</sup>                   | 5.70956X10 <sup>-02</sup>                 | 7.50000X10 <sup>-04</sup>                 |
| 2500 | 1.19422X10 <sup>-03</sup>                 | 9.65404X10 <sup>-03</sup>             | 3.01424X10 <sup>-02</sup>                   | 3.66615X10 <sup>-02</sup>                 | 6.00000X10 <sup>-04</sup>                 |
| 3000 | 1.01907X10 <sup>-03</sup>                 | 6.78817X10 <sup>-03</sup>             | 2.11487X10 <sup>-02</sup>                   | 2.55434X10 <sup>-02</sup>                 | 5.00000X10 <sup>-04</sup>                 |
| 3500 | 8.89670X10 <sup>-04</sup>                 | 5.05001X10 <sup>-03</sup>             | 1.57067X10 <sup>-02</sup>                   | 1.88291X10 <sup>-02</sup>                 | 4.28571X10 <sup>-04</sup>                 |
| 4000 | 7.89908X10 <sup>-04</sup>                 | 3.91607X10 <sup>-03</sup>             | 1.21604X10 <sup>-02</sup>                   | 1.44646X10 <sup>-02</sup>                 | 3.75000X10 <sup>-04</sup>                 |
| 4500 | 7.10549X10 <sup>-04</sup>                 | 3.13531X10 <sup>-03</sup>             | 9.71771X10 <sup>-03</sup>                   | 1.14680X10 <sup>-02</sup>                 | 3.33333X10 <sup>-04</sup>                 |
| 5000 | 6.45874X10 <sup>-04</sup>                 | 2.57492X10 <sup>-03</sup>             | 7.96111X10 <sup>-03</sup>                   | 9.32142X10 <sup>-03</sup>                 | 3.00000X10 <sup>-04</sup>                 |
| 5500 | 5.92141X10 <sup>-04</sup>                 | 2.15915X10 <sup>-03</sup>             | 6.65386X10 <sup>-03</sup>                   | 7.73089X10 <sup>-03</sup>                 | 2.72727X10 <sup>-04</sup>                 |
| 6000 | 5.46805X10 <sup>-04</sup>                 | 1.84216X10 <sup>-03</sup>             | 5.65347X10 <sup>-03</sup>                   | 6.51939X10 <sup>-03</sup>                 | 2.50000X10 <sup>-04</sup>                 |
| 6500 | 5.08079X10 <sup>-04</sup>                 | 1.59488X10 <sup>-03</sup>             | 4.86999X10 <sup>-03</sup>                   | 5.57514X10 <sup>-03</sup>                 | 2.30769X10 <sup>-04</sup>                 |
| 7000 | 4.74679X10 <sup>-04</sup>                 | 1.39813X10 <sup>-03</sup>             | 4.24432X10 <sup>-03</sup>                   | 4.82474X10 <sup>-03</sup>                 | 2.14285X10 <sup>-04</sup>                 |
| 7500 | 4.45665X10 <sup>-04</sup>                 | 1.23888X10 <sup>-03</sup>             | 3.73631X10 <sup>-03</sup>                   | 4.21840X10 <sup>-03</sup>                 | 2.00000X10 <sup>-04</sup>                 |
| 8000 | 4.20338X10 <sup>-04</sup>                 | 1.10800X10 <sup>-03</sup>             | 3.31787X10 <sup>-03</sup>                   | 3.72134X10 <sup>-03</sup>                 | 1.87500X10 <sup>-04</sup>                 |

Table VIII

Temperature derivatives of  $\ln$  of partition functions

| T°K  | $\frac{\partial T^2}{\partial T} \frac{\partial \ln f_{N_2}}{\partial T}$ | $\frac{\partial T^2}{\partial T} \frac{\partial \ln f_N}{\partial T}$ | $\frac{\partial T^2}{\partial T} \frac{\partial \ln f_{N_2}}{\partial T}$ | $\frac{\partial T^2}{\partial T} \frac{\partial \ln f_{N_2}}{\partial T}$ | $\frac{\partial T^2}{\partial T} \frac{\partial \ln f_{N_2}}{\partial T}$ |
|------|---|---|---|---|---|
| 2000 | 3.31652X10*00   | 1.50047X10*00   | 3.49102X10*00   | 1.74195X10*00   | 1.50000X10*00   |
| 2500 | 3.39090X10*00   | 1.50482X10*00   | 3.76172X10*00   | 1.69263X10*00   | 1.50000X10*00   |
| 3000 | 3.43699X10*00   | 1.52134X10*00   | 4.02630X10*00   | 1.52053X10*00   | 1.50000X10*00   |
| 3500 | 3.46821X10*00   | 1.55916X10*00   | 4.24048X10*00   | 1.54202X10*00   | 1.50000X10*00   |
| 4000 | 3.49100X10*00   | 1.62320X10*00   | 4.38634X10*00   | 1.56987X10*00   | 1.50000X10*00   |
| 4500 | 3.50878X10*00   | 1.71262X10*00   | 4.46839X10*00   | 1.60105X10*00   | 1.50000X10*00   |
| 5000 | 3.52378X10*00   | 1.82210X10*00   | 4.50123X10*00   | 1.63277X10*00   | 1.50000X10*00   |
| 5500 | 3.53791X10*00   | 1.94395X10*00   | 4.50063X10*00   | 1.66300X10*00   | 1.50000X10*00   |
| 6000 | 3.55337X10*00   | 2.06994X10*00   | 4.47959X10*00   | 1.69056X10*00   | 1.50000X10*00   |
| 6500 | 3.57301X10*00   | 2.19260X10*00   | 4.44745X10*00   | 1.71490X10*00   | 1.50000X10*00   |
| 7000 | 3.60038X10*00   | 2.30598X10*00   | 4.41040X10*00   | 1.73594X10*00   | 1.50000X10*00   |
| 7500 | 3.63964X10*00   | 2.40591X10*00   | 4.37228X10*00   | 1.75391X10*00   | 1.50000X10*00   |
| 8000 | 3.69537X10*00   | 2.49000X10*00   | 4.33533X10*00   | 1.76915X10*00   | 1.50000X10*00   |

Table IX Temperature derivatives of the product of  $T^2$  and temperature derivatives of  $\ln$  of partition functions

| T°K  | X <sub>N<sub>2</sub></sub> | X <sub>N</sub>            | X <sub>N<sub>2</sub><sup>+</sup></sub> | X <sub>N<sup>+</sup></sub> | X <sub>e<sup>-</sup></sub> |
|------|----------------------------|---------------------------|--|----------------------------|----------------------------|
| 2000 | 1.00000X10 <sup>00</sup>   | 1.09740X10 <sup>-08</sup> | 4.58188X10 <sup>-18</sup>              | 2.01225X10 <sup>-23</sup>  | 4.58190X10 <sup>-18</sup>  |
| 2500 | 9.99996X10 <sup>-01</sup>  | 3.16842X10 <sup>-06</sup> | 4.57848X10 <sup>-14</sup>              | 1.73945X10 <sup>-17</sup>  | 4.58022X10 <sup>-14</sup>  |
| 3000 | 9.99862X10 <sup>-01</sup>  | 1.37524X10 <sup>-04</sup> | 2.18415X10 <sup>-11</sup>              | 1.59341X10 <sup>-13</sup>  | 2.20008X10 <sup>-11</sup>  |
| 3500 | 9.97979X10 <sup>-01</sup>  | 2.02042X10 <sup>-03</sup> | 1.79034X10 <sup>-09</sup>              | 1.05873X10 <sup>-10</sup>  | 1.89621X10 <sup>-09</sup>  |
| 4000 | 9.85016X10 <sup>-01</sup>  | 1.49830X10 <sup>-02</sup> | 4.57319X10 <sup>-08</sup>              | 1.28089X10 <sup>-08</sup>  | 5.85409X10 <sup>-08</sup>  |
| 4500 | 9.31317X10 <sup>-01</sup>  | 6.86804X10 <sup>-02</sup> | 4.89028X10 <sup>-07</sup>              | 4.57769X10 <sup>-07</sup>  | 9.46798X10 <sup>-07</sup>  |
| 5000 | 7.87675X10 <sup>-01</sup>  | 2.12305X10 <sup>-01</sup> | 2.64573X10 <sup>-06</sup>              | 6.64251X10 <sup>-06</sup>  | 9.28825X10 <sup>-06</sup>  |
| 5500 | 5.43565X10 <sup>-01</sup>  | 4.56319X10 <sup>-01</sup> | 8.20502X10 <sup>-06</sup>              | 4.92828X10 <sup>-05</sup>  | 5.74879X10 <sup>-05</sup>  |
| 6000 | 2.87342X10 <sup>-01</sup>  | 7.12177X10 <sup>-01</sup> | 1.59174X10 <sup>-05</sup>              | 2.24437X10 <sup>-04</sup>  | 2.640354X10 <sup>-04</sup> |
| 6500 | 1.18484X10 <sup>-01</sup>  | 8.79990X10 <sup>-01</sup> | 2.14618X10 <sup>-05</sup>              | 7.40680X10 <sup>-04</sup>  | 7.62142X10 <sup>-04</sup>  |
| 7000 | 4.28713X10 <sup>-02</sup>  | 9.53088X10 <sup>-01</sup> | 2.31604X10 <sup>-05</sup>              | 1.99669X10 <sup>-03</sup>  | 2.01985X10 <sup>-03</sup>  |
| 7500 | 1.55955X10 <sup>-02</sup>  | 9.75009X10 <sup>-01</sup> | 2.27033X10 <sup>-05</sup>              | 4.67484X10 <sup>-03</sup>  | 4.69754X10 <sup>-03</sup>  |
| 8000 | 6.08031X10 <sup>-03</sup>  | 9.74286X10 <sup>-01</sup> | 2.15355X10 <sup>-05</sup>              | 9.79523X10 <sup>-03</sup>  | 9.81676X10 <sup>-03</sup>  |

*log P/P<sub>0</sub> = 3.0*

| T°K  | X <sub>N<sub>2</sub></sub> | X <sub>N</sub>            | X <sub>N<sub>2</sub><sup>+</sup></sub> | X <sub>N<sup>+</sup></sub> | X <sub>e<sup>-</sup></sub> |
|------|----------------------------|---------------------------|--|----------------------------|----------------------------|
| 2000 | 1.00000X10 <sup>00</sup>   | 3.47030X10 <sup>-09</sup> | 1.44892X10 <sup>-18</sup>              | 2.01225X10 <sup>-24</sup>  | 1.44892X10 <sup>-18</sup>  |
| 2500 | 9.99999X10 <sup>-01</sup>  | 1.00194X10 <sup>-06</sup> | 1.44803X10 <sup>-14</sup>              | 1.73968X10 <sup>-18</sup>  | 1.44821X10 <sup>-14</sup>  |
| 3000 | 9.99956X10 <sup>-01</sup>  | 4.34922X10 <sup>-05</sup> | 6.92455X10 <sup>-12</sup>              | 1.59745X10 <sup>-14</sup>  | 6.94052X10 <sup>-12</sup>  |
| 3500 | 9.99360X10 <sup>-01</sup>  | 6.39578X10 <sup>-04</sup> | 5.77883X10 <sup>-10</sup>              | 1.08028X10 <sup>-11</sup>  | 5.88686X10 <sup>-10</sup>  |
| 4000 | 9.95225X10 <sup>-01</sup>  | 4.77476X10 <sup>-03</sup> | 1.58055X10 <sup>-08</sup>              | 1.39629X10 <sup>-09</sup>  | 1.72018X10 <sup>-08</sup>  |
| 4500 | 9.77484X10 <sup>-01</sup>  | 2.25148X10 <sup>-02</sup> | 1.96217X10 <sup>-07</sup>              | 5.73686X10 <sup>-08</sup>  | 2.53586X10 <sup>-07</sup>  |
| 5000 | 9.24526X10 <sup>-01</sup>  | 7.54686X10 <sup>-02</sup> | 1.32814X10 <sup>-06</sup>              | 1.00986X10 <sup>-06</sup>  | 2.33800X10 <sup>-06</sup>  |
| 5500 | 8.09332X10 <sup>-01</sup>  | 1.90638X10 <sup>-01</sup> | 5.53695X10 <sup>-06</sup>              | 9.33151X10 <sup>-06</sup>  | 1.48684X10 <sup>-05</sup>  |
| 6000 | 6.26178X10 <sup>-01</sup>  | 3.73684X10 <sup>-01</sup> | 1.54810X10 <sup>-05</sup>              | 5.25581X10 <sup>-05</sup>  | 6.80392X10 <sup>-05</sup>  |
| 6500 | 4.14268X10 <sup>-01</sup>  | 5.85263X10 <sup>-01</sup> | 3.09262X10 <sup>-05</sup>              | 2.03023X10 <sup>-04</sup>  | 2.33949X10 <sup>-04</sup>  |
| 7000 | 2.33394X10 <sup>-01</sup>  | 7.65318X10 <sup>-01</sup> | 4.68952X10 <sup>-05</sup>              | 5.96318X10 <sup>-04</sup>  | 6.43213X10 <sup>-04</sup>  |
| 7500 | 1.15624X10 <sup>-01</sup>  | 8.81358X10 <sup>-01</sup> | 5.77775X10 <sup>-05</sup>              | 1.45053X10 <sup>-03</sup>  | 1.50830X10 <sup>-03</sup>  |
| 8000 | 5.36748X10 <sup>-02</sup>  | 9.40006X10 <sup>-01</sup> | 6.22947X10 <sup>-05</sup>              | 3.09678X10 <sup>-03</sup>  | 3.15908X10 <sup>-03</sup>  |

*log P/P<sub>0</sub> = -2.0*

Table X Mole Fractions

| T°K  | $X_{N_2}$                 | $X_N$                     | $X_{N_2^+}$               | $X_{N^+}$                 | $X_{e^-}$                 |
|------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|
| 2000 | 1.00000X10 <sup>+00</sup> | 1.09740X10 <sup>-09</sup> | 4.58189X10 <sup>-19</sup> | 2.01225X10 <sup>-25</sup> | 4.58189X10 <sup>-19</sup> |
| 2500 | 9.99999X10 <sup>-01</sup> | 3.16843X10 <sup>-07</sup> | 4.57928X10 <sup>-15</sup> | 1.73975X10 <sup>-19</sup> | 4.57945X10 <sup>-15</sup> |
| 3000 | 9.99986X10 <sup>-01</sup> | 1.37537X10 <sup>-05</sup> | 2.19151X10 <sup>-12</sup> | 1.59873X10 <sup>-15</sup> | 2.19310X10 <sup>-12</sup> |
| 3500 | 9.99797X10 <sup>-01</sup> | 2.02318X10 <sup>-04</sup> | 1.83960X10 <sup>-10</sup> | 1.08736X10 <sup>-12</sup> | 1.85048X10 <sup>-10</sup> |
| 4000 | 9.98486X10 <sup>-01</sup> | 1.51362X10 <sup>-03</sup> | 5.15559X10 <sup>-09</sup> | 1.43910X10 <sup>-10</sup> | 5.29950X10 <sup>-09</sup> |
| 4500 | 9.92796X10 <sup>-01</sup> | 7.20309X10 <sup>-03</sup> | 6.82891X10 <sup>-08</sup> | 6.28909X10 <sup>-09</sup> | 7.45782X10 <sup>-08</sup> |
| 5000 | 9.75168X10 <sup>-01</sup> | 2.48305X10 <sup>-02</sup> | 5.21253X10 <sup>-07</sup> | 1.23630X10 <sup>-07</sup> | 6.44884X10 <sup>-07</sup> |
| 5500 | 9.33084X10 <sup>-01</sup> | 6.69073X10 <sup>-02</sup> | 2.58885X10 <sup>-06</sup> | 1.32818X10 <sup>-06</sup> | 3.91703X10 <sup>-06</sup> |
| 6000 | 8.52765X10 <sup>-01</sup> | 1.47198X10 <sup>-01</sup> | 9.08088X10 <sup>-06</sup> | 8.91729X10 <sup>-06</sup> | 1.79981X10 <sup>-05</sup> |
| 6500 | 7.28520X10 <sup>-01</sup> | 2.71349X10 <sup>-01</sup> | 2.38649X10 <sup>-05</sup> | 4.13043X10 <sup>-05</sup> | 6.51693X10 <sup>-05</sup> |
| 7000 | 5.71869X10 <sup>-01</sup> | 4.27747X10 <sup>-01</sup> | 4.91497X10 <sup>-05</sup> | 1.42563X10 <sup>-04</sup> | 1.91713X10 <sup>-04</sup> |
| 7500 | 4.09340X10 <sup>-01</sup> | 5.89712X10 <sup>-01</sup> | 8.24086X10 <sup>-05</sup> | 3.91017X10 <sup>-04</sup> | 4.73425X10 <sup>-04</sup> |
| 8000 | 2.68189X10 <sup>-01</sup> | 7.29776X10 <sup>-01</sup> | 1.16601X10 <sup>-04</sup> | 9.00643X10 <sup>-04</sup> | 1.01724X10 <sup>-03</sup> |

$\log P/P_0 = -1.0$

| T°K  | $X_{N_2}$                 | $X_N$                     | $X_{N_2^+}$               | $X_{N^+}$                 | $X_{e^-}$                 |
|------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|
| 2000 | 1.00000X10 <sup>+00</sup> | 3.47030X10 <sup>-10</sup> | 1.44892X10 <sup>-19</sup> | 2.01225X10 <sup>-26</sup> | 1.44892X10 <sup>-19</sup> |
| 2500 | 9.99999X10 <sup>-01</sup> | 1.00194X10 <sup>-07</sup> | 1.44811X10 <sup>-15</sup> | 1.73977X10 <sup>-20</sup> | 1.44813X10 <sup>-15</sup> |
| 3000 | 9.99995X10 <sup>-01</sup> | 4.34935X10 <sup>-06</sup> | 6.93194X10 <sup>-13</sup> | 1.59914X10 <sup>-16</sup> | 6.93354X10 <sup>-13</sup> |
| 3500 | 9.99936X10 <sup>-01</sup> | 6.39854X10 <sup>-05</sup> | 5.82967X10 <sup>-11</sup> | 1.08963X10 <sup>-13</sup> | 5.84056X10 <sup>-11</sup> |
| 4000 | 9.99521X10 <sup>-01</sup> | 4.79020X10 <sup>-04</sup> | 1.64697X10 <sup>-09</sup> | 1.45340X10 <sup>-11</sup> | 1.66150X10 <sup>-09</sup> |
| 4500 | 9.97713X10 <sup>-01</sup> | 2.28626X10 <sup>-03</sup> | 2.23287X10 <sup>-08</sup> | 6.49474X10 <sup>-10</sup> | 2.29781X10 <sup>-08</sup> |
| 5000 | 9.92046X10 <sup>-01</sup> | 7.95353X10 <sup>-03</sup> | 1.79142X10 <sup>-07</sup> | 1.33782X10 <sup>-08</sup> | 1.92521X10 <sup>-07</sup> |
| 5500 | 9.78084X10 <sup>-01</sup> | 2.19128X10 <sup>-02</sup> | 9.68218X10 <sup>-07</sup> | 1.55200X10 <sup>-07</sup> | 1.12341X10 <sup>-06</sup> |
| 6000 | 9.49602X10 <sup>-01</sup> | 5.03875X10 <sup>-02</sup> | 3.83543X10 <sup>-06</sup> | 1.15778X10 <sup>-06</sup> | 4.99322X10 <sup>-06</sup> |
| 6500 | 8.99972X10 <sup>-01</sup> | 9.99915X10 <sup>-02</sup> | 1.18017X10 <sup>-05</sup> | 6.09298X10 <sup>-06</sup> | 1.78947X10 <sup>-05</sup> |
| 7000 | 8.24848X10 <sup>-01</sup> | 1.75044X10 <sup>-01</sup> | 2.94212X10 <sup>-05</sup> | 2.42121X10 <sup>-05</sup> | 5.36333X10 <sup>-05</sup> |
| 7500 | 7.25096X10 <sup>-01</sup> | 2.74628X10 <sup>-01</sup> | 6.13583X10 <sup>-05</sup> | 7.65403X10 <sup>-05</sup> | 1.37898X10 <sup>-04</sup> |
| 8000 | 6.07998X10 <sup>-01</sup> | 3.91379X10 <sup>-01</sup> | 1.09848X10 <sup>-04</sup> | 2.00718X10 <sup>-04</sup> | 3.10566X10 <sup>-04</sup> |

$\log P/P_0 = 0$

Table X Mole fractions

| T°K  | X <sub>N<sub>2</sub></sub> | X <sub>N</sub>            | X <sub>N<sub>2</sub></sub> <sup>+</sup> | X <sub>N<sub>2</sub></sub> <sup>+</sup> | X <sub>N<sub>2</sub></sub> <sup>+</sup> | X <sub>e</sub> <sup>-</sup> |
|------|----------------------------|---------------------------|---|---|---|-----------------------------|
| 2000 | 1.00000X10 <sup>+00</sup>  | 1.09740X10 <sup>-10</sup> | 4.58189X10 <sup>-20</sup>               | 2.01225X10 <sup>-27</sup>               | 4.58189X10 <sup>-20</sup>               |                             |
| 2500 | 1.00000X10 <sup>+00</sup>  | 3.16843X10 <sup>-08</sup> | 4.57936X10 <sup>-16</sup>               | 1.73978X10 <sup>-21</sup>               | 4.57937X10 <sup>-16</sup>               |                             |
| 3000 | 9.99998X10 <sup>-01</sup>  | 1.37539X10 <sup>-06</sup> | 2.19224X10 <sup>-13</sup>               | 1.59926X10 <sup>-17</sup>               | 2.19240X10 <sup>-13</sup>               |                             |
| 3500 | 9.99979X10 <sup>-01</sup>  | 2.02346X10 <sup>-05</sup> | 1.84474X10 <sup>-11</sup>               | 1.09035X10 <sup>-14</sup>               | 1.84583X10 <sup>-11</sup>               |                             |
| 4000 | 9.99848X10 <sup>-01</sup>  | 1.51516X10 <sup>-04</sup> | 5.22512X10 <sup>-10</sup>               | 1.45801X10 <sup>-12</sup>               | 5.23970X10 <sup>-10</sup>               |                             |
| 4500 | 9.99276X10 <sup>-01</sup>  | 7.23829X10 <sup>-04</sup> | 7.13858X10 <sup>-09</sup>               | 6.56357X10 <sup>-11</sup>               | 7.20421X10 <sup>-09</sup>               |                             |
| 5000 | 9.97474X10 <sup>-01</sup>  | 2.52543X10 <sup>-03</sup> | 5.82845X10 <sup>-08</sup>               | 1.37454X10 <sup>-09</sup>               | 5.96590X10 <sup>-08</sup>               |                             |
| 5500 | 9.92991X10 <sup>-01</sup>  | 7.00831X10 <sup>-03</sup> | 3.25442X10 <sup>-07</sup>               | 1.64339X10 <sup>-08</sup>               | 3.41876X10 <sup>-07</sup>               |                             |
| 6000 | 9.83639X10 <sup>-01</sup>  | 1.63579X10 <sup>-02</sup> | 1.35792X10 <sup>-06</sup>               | 1.28469X10 <sup>-07</sup>               | 1.48638X10 <sup>-06</sup>               |                             |
| 6500 | 9.66648X10 <sup>-01</sup>  | 3.33405X10 <sup>-02</sup> | 4.49848X10 <sup>-06</sup>               | 7.20975X10 <sup>-07</sup>               | 5.21946X10 <sup>-06</sup>               |                             |
| 7000 | 9.39085X10 <sup>-01</sup>  | 6.08837X10 <sup>-02</sup> | 1.23509X10 <sup>-05</sup>               | 3.10523X10 <sup>-06</sup>               | 1.54561X10 <sup>-05</sup>               |                             |
| 7570 | 8.98502X10 <sup>-01</sup>  | 1.01417X10 <sup>-01</sup> | 2.90032X10 <sup>-05</sup>               | 1.07822X10 <sup>-05</sup>               | 3.97855X10 <sup>-05</sup>               |                             |
| 8000 | 8.43695X10 <sup>-01</sup>  | 1.56122X10 <sup>-01</sup> | 5.96578X10 <sup>-05</sup>               | 3.13362X10 <sup>-05</sup>               | 9.09940X10 <sup>-05</sup>               |                             |

log P/P<sub>0</sub> = 1.0

Table X Mole fractions



|              |                                       |                                       |                                       |                                       |                                       |                                       |                                       |
|--------------|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|
| $T^{\circ}K$ | $\frac{\partial X_{N_2}}{\partial T}$ | $\frac{\partial X_{N_2}}{\partial T}$ | $\frac{\partial X_{N_2}}{\partial T}$ | $\frac{\partial X_{N_2}}{\partial T}$ | $\frac{\partial X_{N_2}}{\partial T}$ | $\frac{\partial X_{N_2}}{\partial T}$ | $\frac{\partial X_{N_2}}{\partial T}$ |
| 2000         | -1.55541X10 <sup>-11</sup>            | 1.55541X10 <sup>-11</sup>             | 1.05264X10 <sup>-20</sup>             | 6.87153X10 <sup>-27</sup>             | 6.87153X10 <sup>-27</sup>             | 1.05264X10 <sup>-20</sup>             | 3.32876X10 <sup>-21</sup>             |
| 2500         | -2.86963X10 <sup>-09</sup>            | 2.86963X10 <sup>-09</sup>             | 6.76542X10 <sup>-17</sup>             | 3.80836X10 <sup>-21</sup>             | 3.80836X10 <sup>-21</sup>             | 6.76542X10 <sup>-17</sup>             | 2.13949X10 <sup>-17</sup>             |
| 3000         | -8.63541X10 <sup>-08</sup>            | 8.63541X10 <sup>-08</sup>             | 2.26010X10 <sup>-14</sup>             | 2.43284X10 <sup>-17</sup>             | 2.43284X10 <sup>-17</sup>             | 2.26010X10 <sup>-14</sup>             | 7.15221X10 <sup>-15</sup>             |
| 3500         | -9.31576X10 <sup>-07</sup>            | 9.31576X10 <sup>-07</sup>             | 1.40024X10 <sup>-12</sup>             | 1.621557X10 <sup>-14</sup>            | 1.621557X10 <sup>-14</sup>            | 1.40024X10 <sup>-12</sup>             | 4.45398X10 <sup>-13</sup>             |
| 4000         | -5.32365X10 <sup>-06</sup>            | 5.32365X10 <sup>-06</sup>             | 3.00680X10 <sup>-11</sup>             | 1.22792X10 <sup>-12</sup>             | 1.22792X10 <sup>-12</sup>             | 3.00680X10 <sup>-11</sup>             | 9.77519X10 <sup>-12</sup>             |
| 4500         | -1.99173X10 <sup>-05</sup>            | 1.99173X10 <sup>-05</sup>             | 3.11824X10 <sup>-10</sup>             | 4.19911X10 <sup>-11</sup>             | 4.19911X10 <sup>-11</sup>             | 3.11824X10 <sup>-10</sup>             | 1.07888X10 <sup>-10</sup>             |
| 5000         | -5.48796X10 <sup>-05</sup>            | 5.48796X10 <sup>-05</sup>             | 1.87801X10 <sup>-09</sup>             | 6.55288X10 <sup>-10</sup>             | 6.55288X10 <sup>-10</sup>             | 1.87801X10 <sup>-09</sup>             | 7.41748X10 <sup>-10</sup>             |
| 5500         | -1.18386X10 <sup>-04</sup>            | 1.18386X10 <sup>-04</sup>             | 7.33889X10 <sup>-09</sup>             | 5.63247X10 <sup>-09</sup>             | 5.63247X10 <sup>-09</sup>             | 7.33889X10 <sup>-09</sup>             | 3.63101X10 <sup>-09</sup>             |
| 6000         | -2.05161X10 <sup>-04</sup>            | 2.05161X10 <sup>-04</sup>             | 2.00174X10 <sup>-08</sup>             | 3.03953X10 <sup>-08</sup>             | 3.03953X10 <sup>-08</sup>             | 2.00174X10 <sup>-08</sup>             | 1.37475X10 <sup>-08</sup>             |
| 6500         | -2.87915X10 <sup>-04</sup>            | 2.87915X10 <sup>-04</sup>             | 3.99793X10 <sup>-08</sup>             | 1.13533X10 <sup>-07</sup>             | 1.13533X10 <sup>-07</sup>             | 3.99793X10 <sup>-08</sup>             | 4.23081X10 <sup>-08</sup>             |
| 7000         | -3.29284X10 <sup>-04</sup>            | 3.29284X10 <sup>-04</sup>             | 6.03112X10 <sup>-08</sup>             | 3.17618X10 <sup>-07</sup>             | 3.17618X10 <sup>-07</sup>             | 6.03112X10 <sup>-08</sup>             | 1.09123X10 <sup>-07</sup>             |
| 7500         | -3.11257X10 <sup>-04</sup>            | 3.09688X10 <sup>-04</sup>             | 7.02139X10 <sup>-08</sup>             | 7.14165X10 <sup>-07</sup>             | 7.14165X10 <sup>-07</sup>             | 7.02139X10 <sup>-08</sup>             | 2.41267X10 <sup>-07</sup>             |
| 8000         | -2.48329X10 <sup>-04</sup>            | 2.45452X10 <sup>-04</sup>             | 6.39023X10 <sup>-08</sup>             | 6.39023X10 <sup>-08</sup>             | 6.39023X10 <sup>-08</sup>             | 6.39023X10 <sup>-08</sup>             | 4.67222X10 <sup>-07</sup>             |
| $T^{\circ}K$ | $\frac{\partial X_{N_2}}{\partial T}$ | $\frac{\partial X_{N_2}}{\partial T}$ | $\frac{\partial X_{N_2}}{\partial T}$ | $\frac{\partial X_{N_2}}{\partial T}$ | $\frac{\partial X_{N_2}}{\partial T}$ | $\frac{\partial X_{N_2}}{\partial T}$ | $\frac{\partial X_{N_2}}{\partial T}$ |
| 2000         | -4.91864X10 <sup>-12</sup>            | 4.91864X10 <sup>-12</sup>             | 3.32876X10 <sup>-21</sup>             | 6.87154X10 <sup>-28</sup>             | 6.87154X10 <sup>-28</sup>             | 3.32876X10 <sup>-21</sup>             | 3.32876X10 <sup>-21</sup>             |
| 2500         | -9.07457X10 <sup>-10</sup>            | 9.07457X10 <sup>-10</sup>             | 2.13945X10 <sup>-17</sup>             | 3.80842X10 <sup>-22</sup>             | 3.80842X10 <sup>-22</sup>             | 2.13945X10 <sup>-17</sup>             | 2.13949X10 <sup>-17</sup>             |
| 3000         | -2.73079X10 <sup>-08</sup>            | 2.73079X10 <sup>-08</sup>             | 7.14977X10 <sup>-15</sup>             | 2.43365X10 <sup>-18</sup>             | 2.43365X10 <sup>-18</sup>             | 7.14977X10 <sup>-15</sup>             | 7.15221X10 <sup>-15</sup>             |
| 3500         | -2.94651X10 <sup>-07</sup>            | 2.94650X10 <sup>-07</sup>             | 4.44180X10 <sup>-13</sup>             | 1.21892X10 <sup>-15</sup>             | 1.21892X10 <sup>-15</sup>             | 4.44180X10 <sup>-13</sup>             | 4.45398X10 <sup>-13</sup>             |
| 4000         | -1.68610X10 <sup>-06</sup>            | 1.68608X10 <sup>-06</sup>             | 9.65079X10 <sup>-12</sup>             | 1.24400X10 <sup>-13</sup>             | 1.24400X10 <sup>-13</sup>             | 9.65079X10 <sup>-12</sup>             | 9.77519X10 <sup>-12</sup>             |
| 4500         | -6.34522X10 <sup>-06</sup>            | 6.34501X10 <sup>-06</sup>             | 1.03509X10 <sup>-10</sup>             | 4.37931X10 <sup>-12</sup>             | 4.37931X10 <sup>-12</sup>             | 1.03509X10 <sup>-10</sup>             | 1.07888X10 <sup>-10</sup>             |
| 5000         | -1.78058X10 <sup>-05</sup>            | 1.78043X10 <sup>-05</sup>             | 6.69194X10 <sup>-10</sup>             | 7.25540X10 <sup>-11</sup>             | 7.25540X10 <sup>-11</sup>             | 6.69194X10 <sup>-10</sup>             | 7.41748X10 <sup>-10</sup>             |
| 5500         | -4.01603X10 <sup>-05</sup>            | 4.01530X10 <sup>-05</sup>             | 2.94433X10 <sup>-09</sup>             | 6.86680X10 <sup>-10</sup>             | 6.86680X10 <sup>-10</sup>             | 2.94433X10 <sup>-09</sup>             | 3.63101X10 <sup>-09</sup>             |
| 6000         | -7.60719X10 <sup>-05</sup>            | 7.60444X10 <sup>-05</sup>             | 9.52838X10 <sup>-09</sup>             | 4.21916X10 <sup>-09</sup>             | 4.21916X10 <sup>-09</sup>             | 9.52838X10 <sup>-09</sup>             | 1.37475X10 <sup>-08</sup>             |
| 6500         | -1.24005X10 <sup>-04</sup>            | 1.23920X10 <sup>-04</sup>             | 2.39025X10 <sup>-08</sup>             | 1.84055X10 <sup>-08</sup>             | 1.84055X10 <sup>-08</sup>             | 2.39025X10 <sup>-08</sup>             | 4.23081X10 <sup>-08</sup>             |
| 7000         | -1.76251X10 <sup>-04</sup>            | 1.76033X10 <sup>-04</sup>             | 4.82219X10 <sup>-08</sup>             | 6.09010X10 <sup>-08</sup>             | 6.09010X10 <sup>-08</sup>             | 4.82219X10 <sup>-08</sup>             | 1.09123X10 <sup>-07</sup>             |
| 7500         | -2.20262X10 <sup>-04</sup>            | 2.19779X10 <sup>-04</sup>             | 8.03484X10 <sup>-08</sup>             | 1.60919X10 <sup>-07</sup>             | 1.60919X10 <sup>-07</sup>             | 8.03484X10 <sup>-08</sup>             | 2.41267X10 <sup>-07</sup>             |
| 8000         | -2.44036X10 <sup>-04</sup>            | 2.43102X10 <sup>-04</sup>             | 1.12840X10 <sup>-07</sup>             | 3.54381X10 <sup>-07</sup>             | 3.54381X10 <sup>-07</sup>             | 1.12840X10 <sup>-07</sup>             | 4.67222X10 <sup>-07</sup>             |

$\log \frac{1}{P_0} = -1.0$

$\log \frac{1}{P_0} = 0$

Table XI (Cont.) Temperature derivatives of mole fractions (density constant)

| T °K | $\frac{\partial X_{N_2}}{\partial T}$ | $\frac{\partial X_N}{\partial T}$ | $\frac{\partial X_{N_2}^+}{\partial T}$ | $\frac{\partial X_{N_1}^+}{\partial T}$ | $\frac{\partial X_{N_1}^+}{\partial T}$ | $\frac{\partial X_{N_1}^+}{\partial T}$ |
|------|---------------------------------------|-----------------------------------|---|---|---|---|
| 2000 | -1.55541X10 <sup>-12</sup>            | 1.55541X10 <sup>-12</sup>         | 1.05264X10 <sup>-21</sup>               | 1.05264X10 <sup>-21</sup>               | 6.87154X10 <sup>-29</sup>               | 1.05264X10 <sup>-21</sup>               |
| 2500 | -2.86963X10 <sup>-10</sup>            | 2.86963X10 <sup>-10</sup>         | 6.76559X10 <sup>-18</sup>               | 6.76559X10 <sup>-18</sup>               | 3.80844X10 <sup>-23</sup>               | 6.76563X10 <sup>-18</sup>               |
| 3000 | -8.63557X10 <sup>-09</sup>            | 8.63557X10 <sup>-09</sup>         | 2.26122X10 <sup>-15</sup>               | 2.26122X10 <sup>-15</sup>               | 2.43391X10 <sup>-19</sup>               | 2.26147X10 <sup>-15</sup>               |
| 3500 | -9.31830X10 <sup>-08</sup>            | 9.31828X10 <sup>-08</sup>         | 1.40601X10 <sup>-13</sup>               | 1.40601X10 <sup>-13</sup>               | 1.21998X10 <sup>-16</sup>               | 1.40723X10 <sup>-13</sup>               |
| 4000 | -5.33455X10 <sup>-07</sup>            | 5.33449X10 <sup>-07</sup>         | 3.06643X10 <sup>-12</sup>               | 3.06643X10 <sup>-12</sup>               | 1.24920X10 <sup>-14</sup>               | 3.07892X10 <sup>-12</sup>               |
| 4500 | -2.01125X10 <sup>-06</sup>            | 2.01118X10 <sup>-06</sup>         | 3.32597X10 <sup>-11</sup>               | 3.32597X10 <sup>-11</sup>               | 4.44040X10 <sup>-13</sup>               | 3.37037X10 <sup>-11</sup>               |
| 5000 | -5.67693X10 <sup>-06</sup>            | 5.67647X10 <sup>-06</sup>         | 2.20545X10 <sup>-10</sup>               | 2.20545X10 <sup>-10</sup>               | 7.51685X10 <sup>-12</sup>               | 2.28062X10 <sup>-10</sup>               |
| 5500 | -1.29905X10 <sup>-05</sup>            | 1.29883X10 <sup>-05</sup>         | 1.01679X10 <sup>-09</sup>               | 1.01679X10 <sup>-09</sup>               | 7.39646X10 <sup>-11</sup>               | 1.09076X10 <sup>-09</sup>               |
| 6000 | -2.53543X10 <sup>-05</sup>            | 2.53462X10 <sup>-05</sup>         | 3.54354X10 <sup>-09</sup>               | 3.54354X10 <sup>-09</sup>               | 4.82447X10 <sup>-10</sup>               | 4.02599X10 <sup>-09</sup>               |
| 6500 | -4.36070X10 <sup>-05</sup>            | 4.35827X10 <sup>-05</sup>         | 9.87715X10 <sup>-09</sup>               | 9.87715X10 <sup>-09</sup>               | 2.28283X10 <sup>-09</sup>               | 1.21599X10 <sup>-08</sup>               |
| 7000 | -6.74889X10 <sup>-05</sup>            | 6.74264X10 <sup>-05</sup>         | 2.29062X10 <sup>-08</sup>               | 2.29062X10 <sup>-08</sup>               | 8.35590X10 <sup>-09</sup>               | 3.12621X10 <sup>-08</sup>               |
| 7500 | -9.52650X10 <sup>-05</sup>            | 9.51244X10 <sup>-05</sup>         | 4.54745X10 <sup>-08</sup>               | 4.54745X10 <sup>-08</sup>               | 2.48072X10 <sup>-08</sup>               | 7.02818X10 <sup>-08</sup>               |
| 8000 | -1.23760X10 <sup>-04</sup>            | 1.23478X10 <sup>-04</sup>         | 7.89326X10 <sup>-08</sup>               | 7.89326X10 <sup>-08</sup>               | 6.19356X10 <sup>-08</sup>               | 1.40868X10 <sup>-07</sup>               |

log P/P<sub>0</sub> = 1.0

Table XI (Cont.) Temperature derivatives of mole fractions (density constant)

| T °K | $\frac{\partial X_{M_1}}{\partial \rho}$ | $\frac{\partial X_{M_2}}{\partial \rho}$ | $\frac{\partial X_{M_3}}{\partial \rho}$ | $\frac{\partial X_{M_4}}{\partial \rho}$ | $\frac{\partial X_{M_5}}{\partial \rho}$ |
|------|--|--|--|--|--|
| 2000 | 5.48703X10 <sup>-06</sup>                | -5.48703X10 <sup>-06</sup>               | -2.29093X10 <sup>-15</sup>               | -2.01225X10 <sup>-20</sup>               | -2.29095X10 <sup>-15</sup>               |
| 2500 | 1.58421X10 <sup>-03</sup>                | -1.58421X10 <sup>-03</sup>               | -2.28880X10 <sup>-11</sup>               | -1.73929X10 <sup>-14</sup>               | -2.29054X10 <sup>-11</sup>               |
| 3000 | 6.87554X10 <sup>-02</sup>                | -6.87554X10 <sup>-02</sup>               | -1.08800X10 <sup>-08</sup>               | -1.59047X10 <sup>-10</sup>               | -1.10391X10 <sup>-08</sup>               |
| 3500 | 1.00868X10 <sup>00</sup>                 | -1.00868X10 <sup>00</sup>                | -8.68811X10 <sup>-07</sup>               | -1.04341X10 <sup>-07</sup>               | -9.73152X10 <sup>-07</sup>               |
| 4000 | 7.40728X10 <sup>00</sup>                 | -7.40722X10 <sup>00</sup>                | -2.00976X10 <sup>-05</sup>               | -1.20578X10 <sup>-05</sup>               | -3.21554X10 <sup>-05</sup>               |
| 4500 | 3.25617X10 <sup>01</sup>                 | -3.25606X10 <sup>01</sup>                | -1.71662X10 <sup>-04</sup>               | -3.93718X10 <sup>-04</sup>               | -5.65380X10 <sup>-04</sup>               |
| 5000 | 8.89041X10 <sup>01</sup>                 | -8.88928X10 <sup>01</sup>                | -6.04889X10 <sup>-04</sup>               | -5.04957X10 <sup>-03</sup>               | -5.65446X10 <sup>-03</sup>               |
| 5500 | 1.45598X10 <sup>02</sup>                 | -1.45532X10 <sup>02</sup>                | -5.53305X10 <sup>-04</sup>               | -3.22388X10 <sup>-02</sup>               | -3.27921X10 <sup>-02</sup>               |
| 6000 | 1.41683X10 <sup>02</sup>                 | -1.41433X10 <sup>02</sup>                | 1.97589X10 <sup>-03</sup>                | -1.27277X10 <sup>-01</sup>               | -1.25301X10 <sup>-01</sup>               |
| 6500 | 8.65565X10 <sup>01</sup>                 | -8.57970X10 <sup>01</sup>                | 6.50827X10 <sup>-03</sup>                | -3.86241X10 <sup>-01</sup>               | -3.79733X10 <sup>-01</sup>               |
| 7000 | 3.89261X10 <sup>01</sup>                 | -3.69269X10 <sup>01</sup>                | 9.66736X10 <sup>-03</sup>                | -1.00928X10 <sup>00</sup>                | -9.99620X10 <sup>-01</sup>               |
| 7500 | 1.72504X10 <sup>01</sup>                 | -1.26051X10 <sup>01</sup>                | 1.06384X10 <sup>-02</sup>                | -2.33329X10 <sup>00</sup>                | -2.32265X10 <sup>00</sup>                |
| 8000 | 1.08882X10 <sup>01</sup>                 | -1.23512X10 <sup>00</sup>                | 1.05336X10 <sup>-02</sup>                | -4.83708X10 <sup>00</sup>                | -4.82654X10 <sup>00</sup>                |

  

| T °K | $\frac{\partial X_{M_1}}{\partial \rho}$ | $\frac{\partial X_{M_2}}{\partial \rho}$ | $\frac{\partial X_{M_3}}{\partial \rho}$ | $\frac{\partial X_{M_4}}{\partial \rho}$ | $\frac{\partial X_{M_5}}{\partial \rho}$ |
|------|--|--|--|--|--|
| 2000 | 1.73515X10 <sup>-07</sup>                | -1.73515X10 <sup>-07</sup>               | -7.24460X10 <sup>-17</sup>               | -2.01225X10 <sup>-22</sup>               | -7.24462X10 <sup>-17</sup>               |
| 2500 | 5.00972X10 <sup>-05</sup>                | -5.00972X10 <sup>-05</sup>               | -7.23973X10 <sup>-13</sup>               | -1.73963X10 <sup>-16</sup>               | -7.24147X10 <sup>-13</sup>               |
| 3000 | 2.17454X10 <sup>-03</sup>                | -2.17454X10 <sup>-03</sup>               | -3.45817X10 <sup>-10</sup>               | -1.59651X10 <sup>-12</sup>               | -3.47414X10 <sup>-10</sup>               |
| 3500 | 3.19636X10 <sup>-02</sup>                | -3.19635X10 <sup>-02</sup>               | -2.86151X10 <sup>-08</sup>               | -1.07516X10 <sup>-09</sup>               | -2.96903X10 <sup>-08</sup>               |
| 4000 | 2.37884X10 <sup>-01</sup>                | -2.37883X10 <sup>-01</sup>               | -7.55333X10 <sup>-07</sup>               | -1.36626X10 <sup>-07</sup>               | -8.91960X10 <sup>-07</sup>               |
| 4500 | 1.10672X10 <sup>00</sup>                 | -1.10669X10 <sup>00</sup>                | -8.52878X10 <sup>-06</sup>               | -5.37843X10 <sup>-06</sup>               | -1.39072X10 <sup>-05</sup>               |
| 5000 | 3.55868X10 <sup>00</sup>                 | -3.55841X10 <sup>00</sup>                | -4.79945X10 <sup>-05</sup>               | -8.79959X10 <sup>-05</sup>               | -1.35990X10 <sup>-04</sup>               |
| 5500 | 8.14531X10 <sup>00</sup>                 | -8.14355X10 <sup>00</sup>                | -1.44817X10 <sup>-04</sup>               | -7.36584X10 <sup>-04</sup>               | -8.81401X10 <sup>-04</sup>               |
| 6000 | 1.32265X10 <sup>01</sup>                 | -1.32187X10 <sup>01</sup>                | -2.09856X10 <sup>-04</sup>               | -3.68147X10 <sup>-03</sup>               | -3.89132X10 <sup>-03</sup>               |
| 6500 | 1.53110X10 <sup>01</sup>                 | -1.52859X10 <sup>01</sup>                | 3.82705X10 <sup>-05</sup>                | -1.25484X10 <sup>-02</sup>               | -1.25101X10 <sup>-02</sup>               |
| 7000 | 1.30095X10 <sup>01</sup>                 | -1.29445X10 <sup>01</sup>                | 7.82970X10 <sup>-04</sup>                | -3.32806X10 <sup>-02</sup>               | -3.24976X10 <sup>-02</sup>               |
| 7500 | 8.54363X10 <sup>00</sup>                 | -8.39488X10 <sup>00</sup>                | 1.74832X10 <sup>-03</sup>                | -7.61223X10 <sup>-02</sup>               | -7.43740X10 <sup>-02</sup>               |
| 8000 | 4.76786X10 <sup>00</sup>                 | -4.45742X10 <sup>00</sup>                | 2.46998X10 <sup>-03</sup>                | -1.57687X10 <sup>-01</sup>               | -1.55217X10 <sup>-01</sup>               |

log  $\rho$  = -3.0

log  $\rho$  = -2.0

Table XII Density derivatives of mole fractions (temperature constant)

| T °K | $\frac{\partial X_{N_2}}{\partial P}$ | $\frac{\partial X_{N_2}}{\partial P}$ | $\frac{\partial X_{N_2}}{\partial P}$ | $\frac{\partial X_{N_2}}{\partial P}$ | $\frac{\partial X_{N_2}}{\partial P}$ | $\frac{\partial X_{N_2}}{\partial P}$ |
|------|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|
| 2000 | 5.48703X10 <sup>-09</sup>             | -5.48703X10 <sup>-09</sup>            | -2.29094X10 <sup>-18</sup>            | -2.29094X10 <sup>-18</sup>            | -2.01225X10 <sup>-24</sup>            | -2.01225X10 <sup>-24</sup>            |
| 2500 | 1.58421X10 <sup>-06</sup>             | -1.58421X10 <sup>-06</sup>            | -2.28959X10 <sup>-14</sup>            | -2.28959X10 <sup>-14</sup>            | -1.73977X10 <sup>-18</sup>            | -1.73977X10 <sup>-18</sup>            |
| 3000 | 6.87681X10 <sup>-05</sup>             | -6.87681X10 <sup>-05</sup>            | -1.09534X10 <sup>-11</sup>            | -1.09534X10 <sup>-11</sup>            | -1.59843X10 <sup>-14</sup>            | -1.59843X10 <sup>-14</sup>            |
| 3500 | 1.01144X10 <sup>-03</sup>             | -1.01144X10 <sup>-03</sup>            | -9.16961X10 <sup>-10</sup>            | -9.16961X10 <sup>-10</sup>            | -1.08571X10 <sup>-11</sup>            | -1.08571X10 <sup>-11</sup>            |
| 4000 | 7.55957X10 <sup>-03</sup>             | -7.55957X10 <sup>-03</sup>            | -2.53985X10 <sup>-08</sup>            | -2.53985X10 <sup>-08</sup>            | -1.42878X10 <sup>-09</sup>            | -1.42878X10 <sup>-09</sup>            |
| 4500 | 3.58215X10 <sup>-02</sup>             | -3.58215X10 <sup>-02</sup>            | -3.25177X10 <sup>-07</sup>            | -3.25177X10 <sup>-07</sup>            | -6.14495X10 <sup>-08</sup>            | -6.14495X10 <sup>-08</sup>            |
| 5000 | 1.21842X10 <sup>-01</sup>             | -1.21842X10 <sup>-01</sup>            | -2.30622X10 <sup>-06</sup>            | -2.30622X10 <sup>-06</sup>            | -1.16905X10 <sup>-06</sup>            | -1.16905X10 <sup>-06</sup>            |
| 5500 | 3.17693X10 <sup>-01</sup>             | -3.17693X10 <sup>-01</sup>            | -1.00576X10 <sup>-05</sup>            | -1.00576X10 <sup>-05</sup>            | -1.19178X10 <sup>-05</sup>            | -1.19178X10 <sup>-05</sup>            |
| 6000 | 6.53807X10 <sup>-01</sup>             | -6.53807X10 <sup>-01</sup>            | -2.86084X10 <sup>-05</sup>            | -2.86084X10 <sup>-05</sup>            | -7.45237X10 <sup>-05</sup>            | -7.45237X10 <sup>-05</sup>            |
| 6500 | 1.07338X10 <sup>00</sup>              | -1.07264X10 <sup>00</sup>             | -5.33043X10 <sup>-05</sup>            | -5.33043X10 <sup>-05</sup>            | -3.16366X10 <sup>-04</sup>            | -3.16366X10 <sup>-04</sup>            |
| 7000 | 1.41791X10 <sup>00</sup>              | -1.41582X10 <sup>00</sup>             | -5.69228X10 <sup>-05</sup>            | -5.69228X10 <sup>-05</sup>            | -9.90168X10 <sup>-04</sup>            | -9.90168X10 <sup>-04</sup>            |
| 7500 | 1.53139X10 <sup>00</sup>              | -1.52647X10 <sup>00</sup>             | 1.86361X10 <sup>-06</sup>             | 1.86361X10 <sup>-06</sup>             | -2.46349X10 <sup>-03</sup>            | -2.46349X10 <sup>-03</sup>            |
| 8000 | 1.38389X10 <sup>00</sup>              | -1.37374X10 <sup>00</sup>             | 1.42940X10 <sup>-04</sup>             | 1.42940X10 <sup>-04</sup>             | -5.21973X10 <sup>-03</sup>            | -5.21973X10 <sup>-03</sup>            |

$\log P/P_0 = -1.0$

| T °K | $\frac{\partial X_{N_2}}{\partial P}$ | $\frac{\partial X_{N_2}}{\partial P}$ | $\frac{\partial X_{N_2}}{\partial P}$ | $\frac{\partial X_{N_2}}{\partial P}$ | $\frac{\partial X_{N_2}}{\partial P}$ | $\frac{\partial X_{N_2}}{\partial P}$ |
|------|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|
| 2000 | 1.73515X10 <sup>-10</sup>             | -1.73515X10 <sup>-10</sup>            | -7.24461X10 <sup>-20</sup>            | -7.24461X10 <sup>-20</sup>            | -2.01225X10 <sup>-26</sup>            | -2.01225X10 <sup>-26</sup>            |
| 2500 | 5.00973X10 <sup>-08</sup>             | -5.00973X10 <sup>-08</sup>            | -7.24053X10 <sup>-16</sup>            | -7.24053X10 <sup>-16</sup>            | -1.73977X10 <sup>-20</sup>            | -1.73977X10 <sup>-20</sup>            |
| 3000 | 2.17467X10 <sup>-06</sup>             | -2.17467X10 <sup>-06</sup>            | -3.46555X10 <sup>-13</sup>            | -3.46555X10 <sup>-13</sup>            | -1.59904X10 <sup>-16</sup>            | -1.59904X10 <sup>-16</sup>            |
| 3500 | 3.19912X10 <sup>-05</sup>             | -3.19911X10 <sup>-05</sup>            | -2.91197X10 <sup>-11</sup>            | -2.91197X10 <sup>-11</sup>            | -1.08911X10 <sup>-13</sup>            | -1.08911X10 <sup>-13</sup>            |
| 4000 | 2.39426X10 <sup>-04</sup>             | -2.39424X10 <sup>-04</sup>            | -8.19589X10 <sup>-10</sup>            | -8.19589X10 <sup>-10</sup>            | -1.45005X10 <sup>-11</sup>            | -1.45005X10 <sup>-11</sup>            |
| 4500 | 1.14119X10 <sup>-03</sup>             | -1.14117X10 <sup>-03</sup>            | -1.09873X10 <sup>-08</sup>            | -1.09873X10 <sup>-08</sup>            | -6.44511X10 <sup>-10</sup>            | -6.44511X10 <sup>-10</sup>            |
| 5000 | 3.95322X10 <sup>-03</sup>             | -3.95303X10 <sup>-03</sup>            | -8.59184X10 <sup>-08</sup>            | -8.59184X10 <sup>-08</sup>            | -1.31188X10 <sup>-08</sup>            | -1.31188X10 <sup>-08</sup>            |
| 5500 | 1.07771X10 <sup>-02</sup>             | -1.07760X10 <sup>-02</sup>            | -4.42511X10 <sup>-07</sup>            | -4.42511X10 <sup>-07</sup>            | -1.48965X10 <sup>-07</sup>            | -1.48965X10 <sup>-07</sup>            |
| 6000 | 2.42427X10 <sup>-02</sup>             | -2.42373X10 <sup>-02</sup>            | -1.61968X10 <sup>-06</sup>            | -1.61968X10 <sup>-06</sup>            | -1.07539X10 <sup>-06</sup>            | -1.07539X10 <sup>-06</sup>            |
| 6500 | 4.62313X10 <sup>-02</sup>             | -4.62116X10 <sup>-02</sup>            | -4.42251X10 <sup>-06</sup>            | -4.42251X10 <sup>-06</sup>            | -5.41204X10 <sup>-06</sup>            | -5.41204X10 <sup>-06</sup>            |
| 7000 | 7.58921X10 <sup>-02</sup>             | -7.58329X10 <sup>-02</sup>            | -9.25823X10 <sup>-06</sup>            | -9.25823X10 <sup>-06</sup>            | -2.03347X10 <sup>-05</sup>            | -2.03347X10 <sup>-05</sup>            |
| 7500 | 1.08338X10 <sup>-01</sup>             | -1.08187X10 <sup>-01</sup>            | -1.49215X10 <sup>-05</sup>            | -1.49215X10 <sup>-05</sup>            | -6.01917X10 <sup>-05</sup>            | -6.01917X10 <sup>-05</sup>            |
| 8000 | 1.35822X10 <sup>-01</sup>             | -1.35492X10 <sup>-01</sup>            | -1.78221X10 <sup>-05</sup>            | -1.78221X10 <sup>-05</sup>            | -1.46822X10 <sup>-04</sup>            | -1.46822X10 <sup>-04</sup>            |

$\log P/P_0 = 0$

Table XII (Cont.) Density derivatives of mole fractions (temperature constant)

| T °K | $\frac{\partial X_{N_2}}{\partial \rho}$ | $\frac{\partial X_{N_2}}{\partial \rho}$ | $\frac{\partial X_{N_2}}{\partial \rho}$ | $\frac{\partial X_{N_2}}{\partial \rho}$ | $\frac{\partial X_{N_2}}{\partial \rho}$ |
|------|--|--|--|--|--|
| 2000 | 5.48703X10 <sup>-12</sup>                | -5.48703X10 <sup>-12</sup>               | -2.29094X10 <sup>-21</sup>               | -2.01225X10 <sup>-28</sup>               | -2.29094X10 <sup>-21</sup>               |
| 2500 | 1.58421X10 <sup>-09</sup>                | -1.58421X10 <sup>-09</sup>               | -2.28967X10 <sup>-17</sup>               | -1.73978X10 <sup>-22</sup>               | -2.28967X10 <sup>-17</sup>               |
| 3000 | 6.87694X10 <sup>-08</sup>                | -6.87694X10 <sup>-08</sup>               | -1.09608X10 <sup>-14</sup>               | -1.59924X10 <sup>-18</sup>               | -1.09624X10 <sup>-14</sup>               |
| 3500 | 1.01171X10 <sup>-06</sup>                | -1.01171X10 <sup>-06</sup>               | -9.22084X10 <sup>-13</sup>               | -1.09018X10 <sup>-15</sup>               | -9.23174X10 <sup>-13</sup>               |
| 4000 | 7.57504X10 <sup>-06</sup>                | -7.57499X10 <sup>-06</sup>               | -2.60862X10 <sup>-11</sup>               | -1.45694X10 <sup>-13</sup>               | -2.62319X10 <sup>-11</sup>               |
| 4500 | 3.61725X10 <sup>-05</sup>                | -3.61718X10 <sup>-05</sup>               | -3.55109X10 <sup>-10</sup>               | -6.54743X10 <sup>-12</sup>               | -3.61656X10 <sup>-10</sup>               |
| 5000 | 1.26038X10 <sup>-04</sup>                | -1.26032X10 <sup>-04</sup>               | -2.87511X10 <sup>-09</sup>               | -1.36575X10 <sup>-10</sup>               | -3.01168X10 <sup>-09</sup>               |
| 5500 | 3.48607X10 <sup>-04</sup>                | -3.48572X10 <sup>-04</sup>               | -1.57947X10 <sup>-08</sup>               | -1.62073X10 <sup>-09</sup>               | -1.74155X10 <sup>-08</sup>               |
| 6000 | 8.08001X10 <sup>-04</sup>                | -8.07847X10 <sup>-04</sup>               | -6.41155X10 <sup>-08</sup>               | -1.25158X10 <sup>-08</sup>               | -7.66313X10 <sup>-08</sup>               |
| 6500 | 1.62576X10 <sup>-03</sup>                | -1.62521X10 <sup>-03</sup>               | -2.03615X10 <sup>-07</sup>               | -6.89905X10 <sup>-08</sup>               | -2.72606X10 <sup>-07</sup>               |
| 7000 | 2.90603X10 <sup>-03</sup>                | -2.90440X10 <sup>-03</sup>               | -5.26166X10 <sup>-07</sup>               | -2.90023X10 <sup>-07</sup>               | -8.16190X10 <sup>-07</sup>               |
| 7500 | 4.68568X10 <sup>-03</sup>                | -4.68145X10 <sup>-03</sup>               | -1.13690X10 <sup>-06</sup>               | -9.76552X10 <sup>-07</sup>               | -2.11345X10 <sup>-06</sup>               |
| 8000 | 6.88748X10 <sup>-03</sup>                | -6.87783X10 <sup>-03</sup>               | -2.09186X10 <sup>-06</sup>               | -2.73480X10 <sup>-06</sup>               | -4.82667X10 <sup>-06</sup>               |

$$\log P/P_0 = 1.0$$

Table XII (Cont.) Density derivatives of mole fractions  
(temperature constant)

| T°K  | $\frac{S}{R}$             | $S \frac{\text{cal}}{\text{gm} \cdot \text{K}}$ | $\frac{H}{RT}$            | $H \frac{\text{cal}}{\text{gm}}$ | Z                         |
|------|---------------------------|---|---------------------------|----------------------------------|---------------------------|
| 2000 | 3.52611X10 <sup>*01</sup> | 2.50017X10 <sup>*00</sup>                       | 3.89271X10 <sup>*00</sup> | 5.52060X10 <sup>*02</sup>        | 1.00000X10 <sup>*00</sup> |
| 2500 | 3.60099X10 <sup>*01</sup> | 2.55326X10 <sup>*00</sup>                       | 3.98563X10 <sup>*00</sup> | 7.06548X10 <sup>*02</sup>        | 1.00000X10 <sup>*00</sup> |
| 3000 | 3.66352X10 <sup>*01</sup> | 2.59760X10 <sup>*00</sup>                       | 4.05989X10 <sup>*00</sup> | 8.63654X10 <sup>*02</sup>        | 1.00006X10 <sup>*00</sup> |
| 3500 | 3.71994X10 <sup>*01</sup> | 2.63760X10 <sup>*00</sup>                       | 4.14745X10 <sup>*00</sup> | 1.02932X10 <sup>*03</sup>        | 1.00101X10 <sup>*00</sup> |
| 4000 | 3.78572X10 <sup>*01</sup> | 2.68425X10 <sup>*00</sup>                       | 4.37980X10 <sup>*00</sup> | 1.24227X10 <sup>*03</sup>        | 1.00754X10 <sup>*00</sup> |
| 4500 | 3.90035X10 <sup>*01</sup> | 2.76552X10 <sup>*00</sup>                       | 5.12284X10 <sup>*00</sup> | 1.63466X10 <sup>*03</sup>        | 1.03556X10 <sup>*00</sup> |
| 5000 | 4.13333X10 <sup>*01</sup> | 2.93071X10 <sup>*00</sup>                       | 7.02309X10 <sup>*00</sup> | 2.49001X10 <sup>*03</sup>        | 1.11877X10 <sup>*00</sup> |
| 5500 | 4.54592X10 <sup>*01</sup> | 3.22326X10 <sup>*00</sup>                       | 1.06143X10 <sup>*01</sup> | 4.13961X10 <sup>*03</sup>        | 1.29574X10 <sup>*00</sup> |
| 6000 | 5.08525X10 <sup>*01</sup> | 3.60567X10 <sup>*00</sup>                       | 1.52652X10 <sup>*01</sup> | 6.49469X10 <sup>*03</sup>        | 1.55385X10 <sup>*00</sup> |
| 6500 | 5.54615X10 <sup>*01</sup> | 3.93247X10 <sup>*00</sup>                       | 1.88640X10 <sup>*01</sup> | 8.69465X10 <sup>*03</sup>        | 1.78931X10 <sup>*00</sup> |
| 7000 | 5.80444X10 <sup>*01</sup> | 4.11560X10 <sup>*00</sup>                       | 2.02550X10 <sup>*01</sup> | 1.00539X10 <sup>*04</sup>        | 1.92146X10 <sup>*00</sup> |
| 7500 | 5.93143X10 <sup>*01</sup> | 4.20565X10 <sup>*00</sup>                       | 2.03125X10 <sup>*01</sup> | 1.08026X10 <sup>*04</sup>        | 1.97839X10 <sup>*00</sup> |
| 8000 | 6.01469X10 <sup>*01</sup> | 4.26468X10 <sup>*00</sup>                       | 2.00011X10 <sup>*01</sup> | 1.13461X10 <sup>*04</sup>        | 2.00745X10 <sup>*00</sup> |

  

| T°K  | $\frac{S}{R}$             | $S \frac{\text{cal}}{\text{gm} \cdot \text{K}}$ | $\frac{H}{RT}$            | $H \frac{\text{cal}}{\text{gm}}$ | Z                         |
|------|---------------------------|---|---------------------------|----------------------------------|---------------------------|
| 2000 | 3.29585X10 <sup>*01</sup> | 2.33690X10 <sup>*00</sup>                       | 3.89271X10 <sup>*00</sup> | 5.52060X10 <sup>*02</sup>        | 1.00000X10 <sup>*00</sup> |
| 2500 | 3.37073X10 <sup>*01</sup> | 2.39000X10 <sup>*00</sup>                       | 3.98558X10 <sup>*00</sup> | 7.06539X10 <sup>*02</sup>        | 1.00000X10 <sup>*00</sup> |
| 3000 | 3.43307X10 <sup>*01</sup> | 2.43420X10 <sup>*00</sup>                       | 4.05807X10 <sup>*00</sup> | 8.63268X10 <sup>*02</sup>        | 1.00002X10 <sup>*00</sup> |
| 3500 | 3.48731X10 <sup>*01</sup> | 2.47266X10 <sup>*00</sup>                       | 4.12447X10 <sup>*00</sup> | 1.02362X10 <sup>*03</sup>        | 1.00031X10 <sup>*00</sup> |
| 4000 | 3.53991X10 <sup>*01</sup> | 2.50995X10 <sup>*00</sup>                       | 4.22943X10 <sup>*00</sup> | 1.19962X10 <sup>*03</sup>        | 1.00239X10 <sup>*00</sup> |
| 4500 | 3.60469X10 <sup>*01</sup> | 2.55589X10 <sup>*00</sup>                       | 4.49374X10 <sup>*00</sup> | 1.43392X10 <sup>*03</sup>        | 1.01138X10 <sup>*00</sup> |
| 5000 | 3.70723X10 <sup>*01</sup> | 2.62859X10 <sup>*00</sup>                       | 5.15178X10 <sup>*00</sup> | 1.82655X10 <sup>*03</sup>        | 1.03921X10 <sup>*00</sup> |
| 5500 | 3.88237X10 <sup>*01</sup> | 2.75277X10 <sup>*00</sup>                       | 6.52213X10 <sup>*00</sup> | 2.54364X10 <sup>*03</sup>        | 1.10538X10 <sup>*00</sup> |
| 6000 | 4.15767X10 <sup>*01</sup> | 2.94797X10 <sup>*00</sup>                       | 8.83990X10 <sup>*00</sup> | 3.76099X10 <sup>*03</sup>        | 1.22991X10 <sup>*00</sup> |
| 6500 | 4.52182X10 <sup>*01</sup> | 3.20617X10 <sup>*00</sup>                       | 1.19429X10 <sup>*01</sup> | 5.50465X10 <sup>*03</sup>        | 1.41436X10 <sup>*00</sup> |
| 7000 | 4.90274X10 <sup>*01</sup> | 3.47626X10 <sup>*00</sup>                       | 1.50684X10 <sup>*01</sup> | 7.47945X10 <sup>*03</sup>        | 1.62232X10 <sup>*00</sup> |
| 7500 | 5.20699X10 <sup>*01</sup> | 3.69199X10 <sup>*00</sup>                       | 1.72783X10 <sup>*01</sup> | 9.18897X10 <sup>*03</sup>        | 1.79505X10 <sup>*00</sup> |
| 8000 | 5.40146X10 <sup>*01</sup> | 3.82988X10 <sup>*00</sup>                       | 1.82971X10 <sup>*01</sup> | 1.03795X10 <sup>*04</sup>        | 1.90371X10 <sup>*00</sup> |

Table XIII Entropy, enthalpy, compressibility factor

| T°K  | $\frac{S}{R}$             | $\frac{S_{cal}}{gm \cdot ^\circ K}$ | $\frac{H}{RT}$            | $\frac{H_{cal}}{gm}$      | Z                         |
|------|---------------------------|-------------------------------------|---------------------------|---------------------------|---------------------------|
| 2000 | 3.06559X10 <sup>*01</sup> | 2.17364X10 <sup>*00</sup>           | 3.89271X10 <sup>*00</sup> | 5.52060X10 <sup>*02</sup> | 1.00000X10 <sup>*00</sup> |
| 2500 | 3.14047X10 <sup>*01</sup> | 2.22673X10 <sup>*00</sup>           | 3.98557X10 <sup>*00</sup> | 7.06536X10 <sup>*02</sup> | 1.00000X10 <sup>*00</sup> |
| 3000 | 3.20276X10 <sup>*01</sup> | 2.27090X10 <sup>*00</sup>           | 4.05750X10 <sup>*00</sup> | 8.63145X10 <sup>*02</sup> | 1.00000X10 <sup>*00</sup> |
| 3500 | 3.25631X10 <sup>*01</sup> | 2.30886X10 <sup>*00</sup>           | 4.11720X10 <sup>*00</sup> | 1.02182X10 <sup>*03</sup> | 1.00010X10 <sup>*00</sup> |
| 4000 | 3.30471X10 <sup>*01</sup> | 2.34319X10 <sup>*00</sup>           | 4.18172X10 <sup>*00</sup> | 1.18609X10 <sup>*03</sup> | 1.00075X10 <sup>*00</sup> |
| 4500 | 3.35342X10 <sup>*01</sup> | 2.37772X10 <sup>*00</sup>           | 4.29153X10 <sup>*00</sup> | 1.36939X10 <sup>*03</sup> | 1.00361X10 <sup>*00</sup> |
| 5000 | 3.41154X10 <sup>*01</sup> | 2.41894X10 <sup>*00</sup>           | 4.52507X10 <sup>*00</sup> | 1.60435X10 <sup>*03</sup> | 1.01257X10 <sup>*00</sup> |
| 5500 | 3.49231X10 <sup>*01</sup> | 2.47620X10 <sup>*00</sup>           | 5.00087X10 <sup>*00</sup> | 1.95035X10 <sup>*03</sup> | 1.03461X10 <sup>*00</sup> |
| 6000 | 3.61112X10 <sup>*01</sup> | 2.56045X10 <sup>*00</sup>           | 5.85661X10 <sup>*00</sup> | 2.49173X10 <sup>*03</sup> | 1.07947X10 <sup>*00</sup> |
| 6500 | 3.78053X10 <sup>*01</sup> | 2.68057X10 <sup>*00</sup>           | 7.19858X10 <sup>*00</sup> | 3.31790X10 <sup>*03</sup> | 1.15708X10 <sup>*00</sup> |
| 7000 | 4.00261X10 <sup>*01</sup> | 2.83803X10 <sup>*00</sup>           | 9.02586X10 <sup>*00</sup> | 4.48013X10 <sup>*03</sup> | 1.27248X10 <sup>*00</sup> |
| 7500 | 4.26179X10 <sup>*01</sup> | 3.02180X10 <sup>*00</sup>           | 1.11615X10 <sup>*01</sup> | 5.93593X10 <sup>*03</sup> | 1.41949X10 <sup>*00</sup> |
| 8000 | 4.52508X10 <sup>*01</sup> | 3.20848X10 <sup>*00</sup>           | 1.32598X10 <sup>*01</sup> | 7.52198X10 <sup>*03</sup> | 1.57817X10 <sup>*00</sup> |

  

| T°K  | $\frac{S}{R}$             | $\frac{S_{cal}}{gm \cdot ^\circ K}$ | $\frac{H}{RT}$            | $\frac{H_{cal}}{gm}$      | Z                         |
|------|---------------------------|-------------------------------------|---------------------------|---------------------------|---------------------------|
| 2000 | 2.83533X10 <sup>*01</sup> | 2.01038X10 <sup>*00</sup>           | 3.89271X10 <sup>*00</sup> | 5.52060X10 <sup>*02</sup> | 1.00000X10 <sup>*00</sup> |
| 2500 | 2.91021X10 <sup>*01</sup> | 2.06347X10 <sup>*00</sup>           | 3.98555X10 <sup>*00</sup> | 7.06535X10 <sup>*02</sup> | 1.00000X10 <sup>*00</sup> |
| 3000 | 2.97248X10 <sup>*01</sup> | 2.10762X10 <sup>*00</sup>           | 4.05731X10 <sup>*00</sup> | 8.63106X10 <sup>*02</sup> | 1.00000X10 <sup>*00</sup> |
| 3500 | 3.02581X10 <sup>*01</sup> | 2.14543X10 <sup>*00</sup>           | 4.11490X10 <sup>*00</sup> | 1.02125X10 <sup>*03</sup> | 1.00003X10 <sup>*00</sup> |
| 4000 | 3.07289X10 <sup>*01</sup> | 2.17882X10 <sup>*00</sup>           | 4.16662X10 <sup>*00</sup> | 1.18181X10 <sup>*03</sup> | 1.00023X10 <sup>*00</sup> |
| 4500 | 3.11649X10 <sup>*01</sup> | 2.20973X10 <sup>*00</sup>           | 4.22725X10 <sup>*00</sup> | 1.34888X10 <sup>*03</sup> | 1.00114X10 <sup>*00</sup> |
| 5000 | 3.16023X10 <sup>*01</sup> | 2.24075X10 <sup>*00</sup>           | 4.32328X10 <sup>*00</sup> | 1.53280X10 <sup>*03</sup> | 1.00399X10 <sup>*00</sup> |
| 5500 | 3.20903X10 <sup>*01</sup> | 2.27534X10 <sup>*00</sup>           | 4.49492X10 <sup>*00</sup> | 1.75302X10 <sup>*03</sup> | 1.01107X10 <sup>*00</sup> |
| 6000 | 3.26884X10 <sup>*01</sup> | 2.31775X10 <sup>*00</sup>           | 4.79339X10 <sup>*00</sup> | 2.03938X10 <sup>*03</sup> | 1.02585X10 <sup>*00</sup> |
| 6500 | 3.34597X10 <sup>*01</sup> | 2.37244X10 <sup>*00</sup>           | 5.27312X10 <sup>*00</sup> | 2.43044X10 <sup>*03</sup> | 1.05265X10 <sup>*00</sup> |
| 7000 | 3.44586X10 <sup>*01</sup> | 2.44327X10 <sup>*00</sup>           | 5.97942X10 <sup>*00</sup> | 2.96798X10 <sup>*03</sup> | 1.09599X10 <sup>*00</sup> |
| 7500 | 3.57153X10 <sup>*01</sup> | 2.53237X10 <sup>*00</sup>           | 6.93294X10 <sup>*00</sup> | 3.68708X10 <sup>*03</sup> | 1.15940X10 <sup>*00</sup> |
| 8000 | 3.72194X10 <sup>*01</sup> | 2.63902X10 <sup>*00</sup>           | 8.11430X10 <sup>*00</sup> | 4.60304X10 <sup>*03</sup> | 1.24393X10 <sup>*00</sup> |

Table XIII (Cont.) Entropy, enthalpy, compressibility factor

| T°K  | $\frac{S}{R}$             | S $\frac{\text{cal}}{\text{gm}^\circ\text{K}}$ | $\frac{H}{RT}$            | H $\frac{\text{cal}}{\text{gm}}$ | Z                         |
|------|---------------------------|--|---------------------------|----------------------------------|---------------------------|
| 2000 | 2.60507X10 <sup>*01</sup> | 1.84711X10 <sup>*00</sup>                      | 3.89271X10 <sup>*00</sup> | 5.52060X10 <sup>*02</sup>        | 1.00000X10 <sup>*00</sup> |
| 2500 | 2.67995X10 <sup>*01</sup> | 1.90020X10 <sup>*00</sup>                      | 3.98556X10 <sup>*00</sup> | 7.06535X10 <sup>*02</sup>        | 1.00000X10 <sup>*00</sup> |
| 3000 | 2.74221X10 <sup>*01</sup> | 1.94435X10 <sup>*00</sup>                      | 4.05726X10 <sup>*00</sup> | 8.63094X10 <sup>*02</sup>        | 1.00000X10 <sup>*00</sup> |
| 3500 | 2.79548X10 <sup>*01</sup> | 1.98212X10 <sup>*00</sup>                      | 4.11418X10 <sup>*00</sup> | 1.02107X10 <sup>*03</sup>        | 1.00001X10 <sup>*00</sup> |
| 4000 | 2.84214X10 <sup>*01</sup> | 2.01520X10 <sup>*00</sup>                      | 4.16184X10 <sup>*00</sup> | 1.18045X10 <sup>*03</sup>        | 1.00007X10 <sup>*00</sup> |
| 4500 | 2.88411X10 <sup>*01</sup> | 2.04496X10 <sup>*00</sup>                      | 4.20689X10 <sup>*00</sup> | 1.34238X10 <sup>*03</sup>        | 1.00036X10 <sup>*00</sup> |
| 5000 | 2.92328X10 <sup>*01</sup> | 2.07274X10 <sup>*00</sup>                      | 4.25910X10 <sup>*00</sup> | 1.51005X10 <sup>*03</sup>        | 1.00126X10 <sup>*00</sup> |
| 5500 | 2.96175X10 <sup>*01</sup> | 2.10001X10 <sup>*00</sup>                      | 4.33237X10 <sup>*00</sup> | 1.68963X10 <sup>*03</sup>        | 1.00351X10 <sup>*00</sup> |
| 6000 | 3.00187X10 <sup>*01</sup> | 2.12846X10 <sup>*00</sup>                      | 4.44436X10 <sup>*00</sup> | 1.89088X10 <sup>*03</sup>        | 1.00824X10 <sup>*00</sup> |
| 6500 | 3.04618X10 <sup>*01</sup> | 2.15988X10 <sup>*00</sup>                      | 4.61514X10 <sup>*00</sup> | 2.12717X10 <sup>*03</sup>        | 1.01695X10 <sup>*00</sup> |

Table XIII (Cont.) Entropy, enthalpy, compressibility factor

| T °K | $\frac{P}{P_0}$           | $\frac{\partial P/P}{\partial P_0}$ | M gm.                     | $\frac{\partial M}{\partial T} \frac{\text{gms}}{\text{°K}}$ | $\frac{\partial M}{\partial P_0}$ |
|------|---------------------------|-------------------------------------|---------------------------|--|-----------------------------------|
| 2000 | 6.94058X10 <sup>-03</sup> | 6.94058X10 <sup>+00</sup>           | 2.80140X10 <sup>+01</sup> | -2.17866X10 <sup>-09</sup>                                   | 7.68568X10 <sup>-05</sup>         |
| 2500 | 8.67573X10 <sup>-03</sup> | 8.67573X10 <sup>+00</sup>           | 2.80139X10 <sup>+01</sup> | -4.01947X10 <sup>-07</sup>                                   | 2.21900X10 <sup>-02</sup>         |
| 3000 | 1.04115X10 <sup>-02</sup> | 1.04112X10 <sup>+01</sup>           | 2.80120X10 <sup>+01</sup> | -1.20933X10 <sup>-05</sup>                                   | 9.63057X10 <sup>-01</sup>         |
| 3500 | 1.21582X10 <sup>-02</sup> | 1.21521X10 <sup>+01</sup>           | 2.79856X10 <sup>+01</sup> | -1.30130X10 <sup>-04</sup>                                   | 1.41286X10 <sup>+01</sup>         |
| 4000 | 1.39859X10 <sup>-02</sup> | 1.39337X10 <sup>+01</sup>           | 2.78041X10 <sup>+01</sup> | -7.30664X10 <sup>-04</sup>                                   | 1.03754X10 <sup>+02</sup>         |
| 4500 | 1.61716X10 <sup>-02</sup> | 1.58990X10 <sup>+01</sup>           | 2.70519X10 <sup>+01</sup> | -2.53599X10 <sup>-03</sup>                                   | 4.56097X10 <sup>+02</sup>         |
| 5000 | 1.94123X10 <sup>-02</sup> | 1.84469X10 <sup>+01</sup>           | 2.50398X10 <sup>+01</sup> | -5.60939X10 <sup>-03</sup>                                   | 1.24535X10 <sup>+03</sup>         |
| 5500 | 2.47313X10 <sup>-02</sup> | 2.23979X10 <sup>+01</sup>           | 2.16200X10 <sup>+01</sup> | -7.60209X10 <sup>-03</sup>                                   | 2.03984X10 <sup>+03</sup>         |
| 6000 | 3.23540X10 <sup>-02</sup> | 2.87893X10 <sup>+01</sup>           | 1.80286X10 <sup>+01</sup> | -6.23431X10 <sup>-03</sup>                                   | 1.98634X10 <sup>+03</sup>         |
| 6500 | 4.03614X10 <sup>-02</sup> | 3.72219X10 <sup>+01</sup>           | 1.56562X10 <sup>+01</sup> | -3.26554X10 <sup>-03</sup>                                   | 1.21780X10 <sup>+03</sup>         |
| 7000 | 4.66761X10 <sup>-02</sup> | 4.48853X10 <sup>+01</sup>           | 1.45795X10 <sup>+01</sup> | -1.28991X10 <sup>-03</sup>                                   | 5.59375X10 <sup>+02</sup>         |
| 7500 | 5.14920X10 <sup>-02</sup> | 5.04944X10 <sup>+01</sup>           | 1.41599X10 <sup>+01</sup> | -5.32276X10 <sup>-04</sup>                                   | 2.74309X10 <sup>+02</sup>         |
| 8000 | 5.57316X10 <sup>-02</sup> | 5.48520X10 <sup>+01</sup>           | 1.39549X10 <sup>+01</sup> | -3.43197X10 <sup>-04</sup>                                   | 2.20264X10 <sup>+02</sup>         |

  

| T °K | $\frac{P}{P_0}$           | $\frac{\partial P/P}{\partial P_0}$ | M gm.                     | $\frac{\partial M}{\partial T} \frac{\text{gms}}{\text{°K}}$ | $\frac{\partial M}{\partial P_0}$ |
|------|---------------------------|-------------------------------------|---------------------------|--|-----------------------------------|
| 2000 | 6.94058X10 <sup>-02</sup> | 6.94058X10 <sup>+00</sup>           | 2.80140X10 <sup>+01</sup> | -6.88954X10 <sup>-10</sup>                                   | 2.43042X10 <sup>-06</sup>         |
| 2500 | 8.67572X10 <sup>-02</sup> | 8.67572X10 <sup>+00</sup>           | 2.80139X10 <sup>+01</sup> | -1.27107X10 <sup>-07</sup>                                   | 7.01712X10 <sup>-04</sup>         |
| 3000 | 1.04110X10 <sup>-01</sup> | 1.04109X10 <sup>+01</sup>           | 2.80133X10 <sup>+01</sup> | -3.82480X10 <sup>-06</sup>                                   | 3.04588X10 <sup>-02</sup>         |
| 3500 | 1.21499X10 <sup>-01</sup> | 1.21479X10 <sup>+01</sup>           | 2.80050X10 <sup>+01</sup> | -4.12361X10 <sup>-05</sup>                                   | 4.47714X10 <sup>-01</sup>         |
| 4000 | 1.39143X10 <sup>-01</sup> | 1.38977X10 <sup>+01</sup>           | 2.79471X10 <sup>+01</sup> | -2.34652X10 <sup>-04</sup>                                   | 3.33205X10 <sup>+00</sup>         |
| 4500 | 1.57941X10 <sup>-01</sup> | 1.57057X10 <sup>+01</sup>           | 2.76986X10 <sup>+01</sup> | -8.61935X10 <sup>-04</sup>                                   | 1.55019X10 <sup>+01</sup>         |
| 5000 | 1.80319X10 <sup>-01</sup> | 1.76984X10 <sup>+01</sup>           | 2.69568X10 <sup>+01</sup> | -2.24523X10 <sup>-03</sup>                                   | 4.98477X10 <sup>+01</sup>         |
| 5500 | 2.10980X10 <sup>-01</sup> | 2.01481X10 <sup>+01</sup>           | 2.53431X10 <sup>+01</sup> | -4.25209X10 <sup>-03</sup>                                   | 1.14101X10 <sup>+02</sup>         |
| 6000 | 2.56090X10 <sup>-01</sup> | 2.35254X10 <sup>+01</sup>           | 2.27771X10 <sup>+01</sup> | -5.81576X10 <sup>-03</sup>                                   | 1.85315X10 <sup>+02</sup>         |
| 6500 | 3.19035X10 <sup>-01</sup> | 2.84463X10 <sup>+01</sup>           | 1.98068X10 <sup>+01</sup> | -5.75863X10 <sup>-03</sup>                                   | 2.14637X10 <sup>+02</sup>         |
| 7000 | 3.94095X10 <sup>-01</sup> | 3.52401X10 <sup>+01</sup>           | 1.72678X10 <sup>+01</sup> | -4.24403X10 <sup>-03</sup>                                   | 1.82690X10 <sup>+02</sup>         |
| 7500 | 4.67201X10 <sup>-01</sup> | 4.31056X10 <sup>+01</sup>           | 1.56062X10 <sup>+01</sup> | -2.45251X10 <sup>-03</sup>                                   | 1.20736X10 <sup>+02</sup>         |
| 8000 | 5.28515X10 <sup>-01</sup> | 5.03736X10 <sup>+01</sup>           | 1.47154X10 <sup>+01</sup> | -1.22908X10 <sup>-03</sup>                                   | 6.89922X10 <sup>+01</sup>         |

*log P/P<sub>0</sub> = -3.0*

*log P/P<sub>0</sub> = -2.0*

Table XIV Pressure, density derivative of pressure (temperature constant), molecular weight, temperature and density derivative of molecular weight

| $T^{\circ}K$ | $\frac{P}{P_0}$           | $\frac{\partial P}{\partial P_0}$ | M gm.                     | $\frac{\partial M}{\partial T} \frac{gms}{^{\circ}K}$ | $\frac{\partial M}{\partial P}$ |
|--------------|---------------------------|-----------------------------------|---------------------------|---|---------------------------------|
| 2000         | 6.94058X10 <sup>-01</sup> | 6.94058X10 <sup>+00</sup>         | 2.80140X10 <sup>+01</sup> | -2.17866X10 <sup>-10</sup>                            | 7.68569X10 <sup>-08</sup>       |
| 2500         | 8.67572X10 <sup>-01</sup> | 8.67572X10 <sup>+00</sup>         | 2.80139X10 <sup>+01</sup> | -4.01949X10 <sup>-08</sup>                            | 2.21901X10 <sup>-05</sup>       |
| 3000         | 1.04109X10 <sup>+00</sup> | 1.04109X10 <sup>+01</sup>         | 2.80138X10 <sup>+01</sup> | -1.20956X10 <sup>-06</sup>                            | 9.63235X10 <sup>-04</sup>       |
| 3500         | 1.21472X10 <sup>+00</sup> | 1.21466X10 <sup>+01</sup>         | 2.80111X10 <sup>+01</sup> | -1.30485X10 <sup>-05</sup>                            | 1.41672X10 <sup>-02</sup>       |
| 4000         | 1.38916X10 <sup>+00</sup> | 1.38864X10 <sup>+01</sup>         | 2.79927X10 <sup>+01</sup> | -7.45684X10 <sup>-05</sup>                            | 1.05886X10 <sup>-01</sup>       |
| 4500         | 1.56727X10 <sup>+00</sup> | 1.56445X10 <sup>+01</sup>         | 2.79131X10 <sup>+01</sup> | -2.78982X10 <sup>-04</sup>                            | 5.01753X10 <sup>-01</sup>       |
| 5000         | 1.75695X10 <sup>+00</sup> | 1.74612X10 <sup>+01</sup>         | 2.76661X10 <sup>+01</sup> | -7.68707X10 <sup>-04</sup>                            | 1.70666X10 <sup>+00</sup>       |
| 5500         | 1.97473X10 <sup>+00</sup> | 1.94227X10 <sup>+01</sup>         | 2.70766X10 <sup>+01</sup> | -1.65831X10 <sup>-03</sup>                            | 4.45010X10 <sup>+00</sup>       |
| 6000         | 2.24764X10 <sup>+00</sup> | 2.16832X10 <sup>+01</sup>         | 2.59515X10 <sup>+01</sup> | -2.87412X10 <sup>-03</sup>                            | 9.15892X10 <sup>+00</sup>       |
| 6500         | 2.61002X10 <sup>+00</sup> | 2.44789X10 <sup>+01</sup>         | 2.42108X10 <sup>+01</sup> | -4.03442X10 <sup>-03</sup>                            | 1.50393X10 <sup>+01</sup>       |
| 7000         | 3.09112X10 <sup>+00</sup> | 2.81206X10 <sup>+01</sup>         | 2.20151X10 <sup>+01</sup> | -4.61673X10 <sup>-03</sup>                            | 1.98746X10 <sup>+01</sup>       |
| 7500         | 3.69455X10 <sup>+00</sup> | 3.29234X10 <sup>+01</sup>         | 1.97351X10 <sup>+01</sup> | -4.36978X10 <sup>-03</sup>                            | 2.14847X10 <sup>+01</sup>       |
| 8000         | 4.38137X10 <sup>+00</sup> | 3.90111X10 <sup>+01</sup>         | 1.77509X10 <sup>+01</sup> | -3.49760X10 <sup>-03</sup>                            | 1.94573X10 <sup>+01</sup>       |

  

| $T^{\circ}K$ | $\frac{P}{P_0}$           | $\frac{\partial P}{\partial P_0}$ | M gm.                     | $\frac{\partial M}{\partial T} \frac{gms}{^{\circ}K}$ | $\frac{\partial M}{\partial P}$ |
|--------------|---------------------------|-----------------------------------|---------------------------|---|---------------------------------|
| 2000         | 6.94058X10 <sup>+00</sup> | 6.94058X10 <sup>+00</sup>         | 2.80140X10 <sup>+01</sup> | -6.88954X10 <sup>-11</sup>                            | 2.43042X10 <sup>-09</sup>       |
| 2500         | 8.67572X10 <sup>+00</sup> | 8.67572X10 <sup>+00</sup>         | 2.80140X10 <sup>+01</sup> | -1.27107X10 <sup>-08</sup>                            | 7.01713X10 <sup>-07</sup>       |
| 3000         | 1.04108X10 <sup>+01</sup> | 1.04108X10 <sup>+01</sup>         | 2.80139X10 <sup>+01</sup> | -3.82502X10 <sup>-07</sup>                            | 3.04606X10 <sup>-05</sup>       |
| 3500         | 1.21464X10 <sup>+01</sup> | 1.21462X10 <sup>+01</sup>         | 2.80131X10 <sup>+01</sup> | -4.12718X10 <sup>-06</sup>                            | 4.48101X10 <sup>-04</sup>       |
| 4000         | 1.38844X10 <sup>+01</sup> | 1.38828X10 <sup>+01</sup>         | 2.80072X10 <sup>+01</sup> | -2.36172X10 <sup>-05</sup>                            | 3.35364X10 <sup>-03</sup>       |
| 4500         | 1.56341X10 <sup>+01</sup> | 1.56252X10 <sup>+01</sup>         | 2.79819X10 <sup>+01</sup> | -8.88776X10 <sup>-05</sup>                            | 1.59847X10 <sup>-02</sup>       |
| 5000         | 1.74207X10 <sup>+01</sup> | 1.73861X10 <sup>+01</sup>         | 2.79025X10 <sup>+01</sup> | -2.49407X10 <sup>-04</sup>                            | 5.53730X10 <sup>-02</sup>       |
| 5500         | 1.92980X10 <sup>+01</sup> | 1.91929X10 <sup>+01</sup>         | 2.77070X10 <sup>+01</sup> | -5.62535X10 <sup>-04</sup>                            | 1.50958X10 <sup>-01</sup>       |
| 6000         | 2.13599X10 <sup>+01</sup> | 2.10943X10 <sup>+01</sup>         | 2.73080X10 <sup>+01</sup> | -1.06559X10 <sup>-03</sup>                            | 3.39583X10 <sup>-01</sup>       |
| 6500         | 2.37445X10 <sup>+01</sup> | 2.31666X10 <sup>+01</sup>         | 2.66128X10 <sup>+01</sup> | -1.73719X10 <sup>-03</sup>                            | 6.47638X10 <sup>-01</sup>       |
| 7000         | 2.66239X10 <sup>+01</sup> | 2.55164X10 <sup>+01</sup>         | 2.55603X10 <sup>+01</sup> | -2.46961X10 <sup>-03</sup>                            | 1.06330X10 <sup>+00</sup>       |
| 7500         | 3.01760X10 <sup>+01</sup> | 2.82798X10 <sup>+01</sup>         | 2.41623X10 <sup>+01</sup> | -3.08746X10 <sup>-03</sup>                            | 1.51833X10 <sup>+00</sup>       |
| 8000         | 3.45345X10 <sup>+01</sup> | 3.16140X10 <sup>+01</sup>         | 2.25204X10 <sup>+01</sup> | -3.42318X10 <sup>-03</sup>                            | 1.90451X10 <sup>+00</sup>       |

$\log P/P_0 = -1.0$

$\log P/P_0 = 0$

Table XIV (Cont.) Pressure, density derivative of pressure (temperature constant), molecular weight, temperature and density derivatives of molecular weight

| T°K  | $\frac{P}{P_0}$           | $\frac{\partial P}{\partial P_0}$ | M gms                     | $\frac{\partial M}{\partial T} \frac{\text{gms}}{\text{°K}}$ | $\frac{\partial M}{\partial P_0}$ |
|------|---------------------------|-----------------------------------|---------------------------|--|-----------------------------------|
| 2000 | 6.94058X10 <sup>+01</sup> | 6.94058X10 <sup>+00</sup>         | 2.80140X10 <sup>+01</sup> | -2.17866X10 <sup>-11</sup>                                   | 7.68569X10 <sup>-11</sup>         |
| 2500 | 8.67572X10 <sup>+01</sup> | 8.67572X10 <sup>+00</sup>         | 2.80140X10 <sup>+01</sup> | -4.01949X10 <sup>-09</sup>                                   | 2.21901X10 <sup>-08</sup>         |
| 3000 | 1.04108X10 <sup>+02</sup> | 1.04108X10 <sup>+01</sup>         | 2.80139X10 <sup>+01</sup> | -1.20958X10 <sup>-07</sup>                                   | 9.63253X10 <sup>-07</sup>         |
| 3500 | 1.21461X10 <sup>+02</sup> | 1.21460X10 <sup>+01</sup>         | 2.80137X10 <sup>+01</sup> | -1.30521X10 <sup>-06</sup>                                   | 1.41711X10 <sup>-05</sup>         |
| 4000 | 1.38822X10 <sup>+02</sup> | 1.38816X10 <sup>+01</sup>         | 2.80118X10 <sup>+01</sup> | -7.47210X10 <sup>-06</sup>                                   | 1.06103X10 <sup>-04</sup>         |
| 4500 | 1.56219X10 <sup>+02</sup> | 1.56191X10 <sup>+01</sup>         | 2.80038X10 <sup>+01</sup> | -2.81716X10 <sup>-05</sup>                                   | 5.06669X10 <sup>-04</sup>         |
| 5000 | 1.73733X10 <sup>+02</sup> | 1.73624X10 <sup>+01</sup>         | 2.79786X10 <sup>+01</sup> | -7.95169X10 <sup>-05</sup>                                   | 1.76542X10 <sup>-03</sup>         |
| 5500 | 1.91537X10 <sup>+02</sup> | 1.91202X10 <sup>+01</sup>         | 2.79158X10 <sup>+01</sup> | -1.81959X10 <sup>-04</sup>                                   | 4.88296X10 <sup>-03</sup>         |
| 6000 | 2.09934X10 <sup>+02</sup> | 2.09079X10 <sup>+01</sup>         | 2.77848X10 <sup>+01</sup> | -3.55145X10 <sup>-04</sup>                                   | 1.13178X10 <sup>-02</sup>         |
| 6500 | 2.29394X10 <sup>+02</sup> | 2.27497X10 <sup>+01</sup>         | 2.75468X10 <sup>+01</sup> | -6.10836X10 <sup>-04</sup>                                   | 2.27730X10 <sup>-02</sup>         |
| 7000 | 2.50551X10 <sup>+02</sup> | 2.46796X10 <sup>+01</sup>         | 2.71607X10 <sup>+01</sup> | -9.45434X10 <sup>-04</sup>                                   | 4.07088X10 <sup>-02</sup>         |
| 7500 | 2.74187X10 <sup>+02</sup> | 2.67419X10 <sup>+01</sup>         | 2.65921X10 <sup>+01</sup> | -1.33472X10 <sup>-03</sup>                                   | 6.56460X10 <sup>-02</sup>         |
| 8000 | 3.01164X10 <sup>+02</sup> | 2.89909X10 <sup>+01</sup>         | 2.58242X10 <sup>+01</sup> | -1.73437X10 <sup>-03</sup>                                   | 9.65113X10 <sup>-02</sup>         |

*log M<sub>0</sub> = 1.0*

Table XIV Pressure, density derivative of pressure (temperature constant), molecular weight, temperature and density derivatives of molecular weight

| T°K  | $C_v \frac{\text{cal}}{\text{gm}^\circ\text{K}}$ | $C_p \frac{\text{cal}}{\text{gm}^\circ\text{K}}$ | $\gamma$                  | $\alpha/a_0$              |
|------|--|--|---------------------------|---------------------------|
| 2000 | 2.35174X10 <sup>-01</sup>                        | 3.06083X10 <sup>-01</sup>                        | 1.30151X10 <sup>+00</sup> | 2.54014X10 <sup>+00</sup> |
| 2500 | 2.40561X10 <sup>-01</sup>                        | 3.11476X10 <sup>-01</sup>                        | 1.29478X10 <sup>+00</sup> | 2.83262X10 <sup>+00</sup> |
| 3000 | 2.47138X10 <sup>-01</sup>                        | 3.18239X10 <sup>-01</sup>                        | 1.28769X10 <sup>+00</sup> | 3.09452X10 <sup>+00</sup> |
| 3500 | 2.82691X10 <sup>-01</sup>                        | 3.56038X10 <sup>-01</sup>                        | 1.25946X10 <sup>+00</sup> | 3.30639X10 <sup>+00</sup> |
| 4000 | 4.55833X10 <sup>-01</sup>                        | 5.43414X10 <sup>-01</sup>                        | 1.19213X10 <sup>+00</sup> | 3.44454X10 <sup>+00</sup> |
| 4500 | 1.00845X10 <sup>+00</sup>                        | 1.15945X10 <sup>+00</sup>                        | 1.14973X10 <sup>+00</sup> | 3.61342X10 <sup>+00</sup> |
| 5000 | 2.19377X10 <sup>+00</sup>                        | 2.56902X10 <sup>+00</sup>                        | 1.17104X10 <sup>+00</sup> | 3.92812X10 <sup>+00</sup> |
| 5500 | 3.74183X10 <sup>+00</sup>                        | 4.61513X10 <sup>+00</sup>                        | 1.23338X10 <sup>+00</sup> | 4.44211X10 <sup>+00</sup> |
| 6000 | 4.33229X10 <sup>+00</sup>                        | 5.50299X10 <sup>+00</sup>                        | 1.27022X10 <sup>+00</sup> | 5.11084X10 <sup>+00</sup> |
| 6500 | 3.10729X10 <sup>+00</sup>                        | 3.87081X10 <sup>+00</sup>                        | 1.24571X10 <sup>+00</sup> | 5.75509X10 <sup>+00</sup> |
| 7000 | 1.62615X10 <sup>+00</sup>                        | 1.99768X10 <sup>+00</sup>                        | 1.22847X10 <sup>+00</sup> | 6.27582X10 <sup>+00</sup> |
| 7500 | 9.64916X10 <sup>-01</sup>                        | 1.20000X10 <sup>+00</sup>                        | 1.24364X10 <sup>+00</sup> | 6.69738X10 <sup>+00</sup> |
| 8000 | 8.50260X10 <sup>-01</sup>                        | 1.05740X10 <sup>+00</sup>                        | 1.24361X10 <sup>+00</sup> | 6.98033X10 <sup>+00</sup> |

$\log P_0 = -3.0$

| T°K  | $C_v \frac{\text{cal}}{\text{gm}^\circ\text{K}}$ | $C_p \frac{\text{cal}}{\text{gm}^\circ\text{K}}$ | $\gamma$                  | $\alpha/a_0$              |
|------|--|--|---------------------------|---------------------------|
| 2000 | 2.35173X10 <sup>-01</sup>                        | 3.06083X10 <sup>-01</sup>                        | 1.30152X10 <sup>+00</sup> | 2.54014X10 <sup>+00</sup> |
| 2500 | 2.40483X10 <sup>-01</sup>                        | 3.11394X10 <sup>-01</sup>                        | 1.29486X10 <sup>+00</sup> | 2.83270X10 <sup>+00</sup> |
| 3000 | 2.44798X10 <sup>-01</sup>                        | 3.15768X10 <sup>-01</sup>                        | 1.28991X10 <sup>+00</sup> | 3.09714X10 <sup>+00</sup> |
| 3500 | 2.57563X10 <sup>-01</sup>                        | 3.29240X10 <sup>-01</sup>                        | 1.27828X10 <sup>+00</sup> | 3.33044X10 <sup>+00</sup> |
| 4000 | 3.13792X10 <sup>-01</sup>                        | 3.89816X10 <sup>-01</sup>                        | 1.24227X10 <sup>+00</sup> | 3.51170X10 <sup>+00</sup> |
| 4500 | 4.95710X10 <sup>-01</sup>                        | 5.89443X10 <sup>-01</sup>                        | 1.18908X10 <sup>+00</sup> | 3.65234X10 <sup>+00</sup> |
| 5000 | 9.26225X10 <sup>-01</sup>                        | 1.07685X10 <sup>+00</sup>                        | 1.16263X10 <sup>+00</sup> | 3.83375X10 <sup>+00</sup> |
| 5500 | 1.69195X10 <sup>+00</sup>                        | 1.99540X10 <sup>+00</sup>                        | 1.17935X10 <sup>+00</sup> | 4.11978X10 <sup>+00</sup> |
| 6000 | 2.67496X10 <sup>+00</sup>                        | 3.28361X10 <sup>+00</sup>                        | 1.22753X10 <sup>+00</sup> | 4.54173X10 <sup>+00</sup> |
| 6500 | 3.40909X10 <sup>+00</sup>                        | 4.34842X10 <sup>+00</sup>                        | 1.27553X10 <sup>+00</sup> | 5.09091X10 <sup>+00</sup> |
| 7000 | 3.32207X10 <sup>+00</sup>                        | 4.27417X10 <sup>+00</sup>                        | 1.28660X10 <sup>+00</sup> | 5.69083X10 <sup>+00</sup> |
| 7500 | 2.47097X10 <sup>+00</sup>                        | 3.12578X10 <sup>+00</sup>                        | 1.26500X10 <sup>+00</sup> | 6.24091X10 <sup>+00</sup> |
| 8000 | 1.58346X10 <sup>+00</sup>                        | 1.97760X10 <sup>+00</sup>                        | 1.24891X10 <sup>+00</sup> | 6.70352X10 <sup>+00</sup> |

$\log P_0 = -2.0$

Table XV Specific heats, specific heat ratio, speed of sound

| T °K | $C_v \frac{\text{cal}}{\text{gm} \cdot \text{K}}$ | $C_p \frac{\text{cal}}{\text{gm} \cdot \text{K}}$ | $\gamma$                  | $\alpha/a_0$              |
|------|---|---|---------------------------|---------------------------|
| 2000 | 2.35173X10 <sup>-01</sup>                         | 3.06083X10 <sup>-01</sup>                         | 1.30152X10 <sup>+00</sup> | 2.54014X10 <sup>+00</sup> |
| 2500 | 2.40458X10 <sup>-01</sup>                         | 3.11368X10 <sup>-01</sup>                         | 1.29489X10 <sup>+00</sup> | 2.83273X10 <sup>+00</sup> |
| 3000 | 2.44058X10 <sup>-01</sup>                         | 3.14986X10 <sup>-01</sup>                         | 1.29062X10 <sup>+00</sup> | 3.09798X10 <sup>+00</sup> |
| 3500 | 2.49609X10 <sup>-01</sup>                         | 3.20761X10 <sup>-01</sup>                         | 1.28505X10 <sup>+00</sup> | 3.33906X10 <sup>+00</sup> |
| 4000 | 2.68532X10 <sup>-01</sup>                         | 3.41043X10 <sup>-01</sup>                         | 1.27002X10 <sup>+00</sup> | 3.54925X10 <sup>+00</sup> |
| 4500 | 3.27565X10 <sup>-01</sup>                         | 4.05416X10 <sup>-01</sup>                         | 1.23766X10 <sup>+00</sup> | 3.71894X10 <sup>+00</sup> |
| 5000 | 4.70316X10 <sup>-01</sup>                         | 5.64031X10 <sup>-01</sup>                         | 1.19925X10 <sup>+00</sup> | 3.86749X10 <sup>+00</sup> |
| 5500 | 7.46458X10 <sup>-01</sup>                         | 8.79763X10 <sup>-01</sup>                         | 1.17858X10 <sup>+00</sup> | 4.04363X10 <sup>+00</sup> |
| 6000 | 1.18503X10 <sup>+00</sup>                         | 1.40486X10 <sup>+00</sup>                         | 1.18550X10 <sup>+00</sup> | 4.28498X10 <sup>+00</sup> |
| 6500 | 1.75463X10 <sup>+00</sup>                         | 2.13426X10 <sup>+00</sup>                         | 1.21635X10 <sup>+00</sup> | 4.61172X10 <sup>+00</sup> |
| 7000 | 2.32942X10 <sup>+00</sup>                         | 2.93354X10 <sup>+00</sup>                         | 1.25934X10 <sup>+00</sup> | 5.02945X10 <sup>+00</sup> |
| 7500 | 2.70356X10 <sup>+00</sup>                         | 3.50317X10 <sup>+00</sup>                         | 1.29575X10 <sup>+00</sup> | 5.52014X10 <sup>+00</sup> |
| 8000 | 2.69804X10 <sup>+00</sup>                         | 3.53224X10 <sup>+00</sup>                         | 1.30919X10 <sup>+00</sup> | 6.03992X10 <sup>+00</sup> |

$\log P/P_0 = -1.0$

| T °K | $C_v \frac{\text{cal}}{\text{gm} \cdot \text{K}}$ | $C_p \frac{\text{cal}}{\text{gm} \cdot \text{K}}$ | $\gamma$                  | $\alpha/a_0$              |
|------|---|---|---------------------------|---------------------------|
| 2000 | 2.35173X10 <sup>-01</sup>                         | 3.06082X10 <sup>-01</sup>                         | 1.30152X10 <sup>+00</sup> | 2.54014X10 <sup>+00</sup> |
| 2500 | 2.40451X10 <sup>-01</sup>                         | 3.11360X10 <sup>-01</sup>                         | 1.29490X10 <sup>+00</sup> | 2.83274X10 <sup>+00</sup> |
| 3000 | 2.43823X10 <sup>-01</sup>                         | 3.14739X10 <sup>-01</sup>                         | 1.29084X10 <sup>+00</sup> | 3.09825X10 <sup>+00</sup> |
| 3500 | 2.47093X10 <sup>-01</sup>                         | 3.18079X10 <sup>-01</sup>                         | 1.28728X10 <sup>+00</sup> | 3.34190X10 <sup>+00</sup> |
| 4000 | 2.54185X10 <sup>-01</sup>                         | 3.25600X10 <sup>-01</sup>                         | 1.28095X10 <sup>+00</sup> | 3.56403X10 <sup>+00</sup> |
| 4500 | 2.73780X10 <sup>-01</sup>                         | 3.46857X10 <sup>-01</sup>                         | 1.26691X10 <sup>+00</sup> | 3.76030X10 <sup>+00</sup> |
| 5000 | 3.20251X10 <sup>-01</sup>                         | 3.98104X10 <sup>-01</sup>                         | 1.24309X10 <sup>+00</sup> | 3.92907X10 <sup>+00</sup> |
| 5500 | 4.11803X10 <sup>-01</sup>                         | 5.00889X10 <sup>-01</sup>                         | 1.21633X10 <sup>+00</sup> | 4.08349X10 <sup>+00</sup> |
| 6000 | 5.65941X10 <sup>-01</sup>                         | 6.78128X10 <sup>-01</sup>                         | 1.19823X10 <sup>+00</sup> | 4.24902X10 <sup>+00</sup> |
| 6500 | 7.92870X10 <sup>-01</sup>                         | 9.48069X10 <sup>-01</sup>                         | 1.19574X10 <sup>+00</sup> | 4.44822X10 <sup>+00</sup> |
| 7000 | 1.08785X10 <sup>+00</sup>                         | 1.31573X10 <sup>+00</sup>                         | 1.20946X10 <sup>+00</sup> | 4.69507X10 <sup>+00</sup> |
| 7500 | 1.42477X10 <sup>+00</sup>                         | 1.76121X10 <sup>+00</sup>                         | 1.23613X10 <sup>+00</sup> | 4.99698X10 <sup>+00</sup> |
| 8000 | 1.75445X10 <sup>+00</sup>                         | 2.22763X10 <sup>+00</sup>                         | 1.26970X10 <sup>+00</sup> | 5.35460X10 <sup>+00</sup> |

$\log P/P_0 = 0$

Table XV (Cont.) Specific heats, specific heat ratio, speed of sound

| T°K  | $C_v \frac{\text{cal}}{\text{gm}^\circ\text{K}}$ | $C_p \frac{\text{cal}}{\text{gm}^\circ\text{K}}$ | $\gamma$                  | a/a.                      |
|------|--|--|---------------------------|---------------------------|
| 2000 | 2.35173X10 <sup>-01</sup>                        | 3.06082X10 <sup>-01</sup>                        | 1.30152X10 <sup>+00</sup> | 2.54014X10 <sup>+00</sup> |
| 2500 | 2.40448X10 <sup>-01</sup>                        | 3.11358X10 <sup>-01</sup>                        | 1.29490X10 <sup>+00</sup> | 2.83274X10 <sup>+00</sup> |
| 3000 | 2.43749X10 <sup>-01</sup>                        | 3.14661X10 <sup>-01</sup>                        | 1.29091X10 <sup>+00</sup> | 3.09833X10 <sup>+00</sup> |
| 3500 | 2.46297X10 <sup>-01</sup>                        | 3.17231X10 <sup>-01</sup>                        | 1.28800X10 <sup>+00</sup> | 3.34281X10 <sup>+00</sup> |
| 4000 | 2.49645X10 <sup>-01</sup>                        | 3.20714X10 <sup>-01</sup>                        | 1.28467X10 <sup>+00</sup> | 3.56906X10 <sup>+00</sup> |
| 4500 | 2.56711X10 <sup>-01</sup>                        | 3.28302X10 <sup>-01</sup>                        | 1.27888X10 <sup>+00</sup> | 3.77728X10 <sup>+00</sup> |
| 5000 | 2.72193X10 <sup>-01</sup>                        | 3.45271X10 <sup>-01</sup>                        | 1.26847X10 <sup>+00</sup> | 3.96626X10 <sup>+00</sup> |
| 5500 | 3.02191X10 <sup>-01</sup>                        | 3.78677X10 <sup>-01</sup>                        | 1.25310X10 <sup>+00</sup> | 4.13691X10 <sup>+00</sup> |
| 6000 | 3.53225X10 <sup>-01</sup>                        | 4.36445X10 <sup>-01</sup>                        | 1.23560X10 <sup>+00</sup> | 4.29566X10 <sup>+00</sup> |
| 6500 | 4.30999X10 <sup>-01</sup>                        | 5.26184X10 <sup>-01</sup>                        | 1.22084X10 <sup>+00</sup> | 4.45404X10 <sup>+00</sup> |
| 7000 | 5.39094X10 <sup>-01</sup>                        | 6.53936X10 <sup>-01</sup>                        | 1.21302X10 <sup>+00</sup> | 4.62424X10 <sup>+00</sup> |
| 7500 | 6.77698X10 <sup>-01</sup>                        | 8.22808X10 <sup>-01</sup>                        | 1.21412X10 <sup>+00</sup> | 4.81574X10 <sup>+00</sup> |
| 8000 | 8.42574X10 <sup>-01</sup>                        | 1.03141X10 <sup>+00</sup>                        | 1.22412X10 <sup>+00</sup> | 5.03478X10 <sup>+00</sup> |

*avg P/P<sub>0</sub> = 1.0*

Table XV (Cont.) Specific heats, specific heat ratio, speed of sound